SCIENCE ABSTRACTS

SECTION A

PHYSICS.

Vol. 36 | MARCH 1933 (Abstracts 813-1244) | No. 423

EDITED AND ISSUED MONTHLY BY

THE INSTITUTION OF ELECTRICAL ENGINEERS.

Savoy Place, Victoria Embankment, London, W.C.2.

IN ASSOCIATION WITH

THE PHYSICAL SOCIETY,

THE AMERICAN PHYSICAL SOCIETY,

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND

L'ASSOCIAZIONE ELETTROTECNICA ITALIANA.

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GENERAL PHYSICS.

ADSORPTION.

813. Adsorption. Part I. Carbon Dioxide, Sulphur Dioxide and Water. Part II. Lower Fatty Acids. R. C. Bosworth. *Faraday Soc., Trans.*, 28. *pp.* 896–912, *Dec.*, 1932.—When drops of mercury fall through a mixture of two or more of CO_2, SO_2, H_2O (vapour), and air the resultant change in composition indicates selective adsorption on the mercury surface with formation of a monomolecular layer of CO_2, SO_2, or H_2O, adsorption being complete in $< 0{\cdot}25$ sec. When two active gases are present adsorption is approximately in proportion to relative concentration, but the layer remains monomolecular; a similar proportion is found if the concentration is such as to produce only an unsaturated layer. There is some evidence of catalytic reduction of adsorbed SO_2 by Hg. In similar fashion drops of mercury falling through dry air impregnated with vapour of formic, acetic, propionic, butyric or valeric acid adsorbs a monomolecular layer (unless the air is very nearly saturated when the layer is multimolecular). The area per molecule of acid rises steadily by about 5Å^2 per CH_2 from 23Å^2 for formic acid to 45Å^2 for valeric, but propionic, butyric and valeric acids can also form films with average area 22Å^2, the larger area being that of the molecule lying horizontally on the surface, the smaller when perpendicular thereto with the COOH group toward the mercury. The results are confirmed by drop-weight determinations of surface tension. Failure to confirm Gibbs' equation is due to diffusion of water vapour. C.A.S.

814. Sorption of Vapours on Wood and Cellulose. N. H. Grace and O. Maass. *J. Phys. Chem.* 36. *pp.* 3046–3063, *Dec.*, 1932.—An experimental method is described whereby adsorption or desorption values are determined at a constant vapour pressure in the case of water vapour, and data are given for the sorption by woods and celluloses of water vapour, hydrogen chloride, sulphur dioxide, ammonia, and carbon dioxide, and of ethyl ether, amylene and methyl alcohol by white spruce heartwood. The authors believe that the hypothesis advanced by Pierce is in the main correct; *viz.*, that water is sorbed in two ways; one involving a surface compound formation perhaps on the basis of one of water to one exposed hexose group, in the other the rest of the water is used to fill spaces available under attractive forces like those in a liquid. It is tentatively suggested that the cellulose micelles offer a certain free surface for this surface addition of water and that this surface is increased when actually liquid water fills the interstices at the edges of the micelles. On this basis the phenomenon of hysteresis is explicable. H. H. Ho.

815. Adsorption of Gases by Active Charcoal. H. Remy and W. Hene. *Kolloid Zeits.* 61. *pp.* 313–322, *Dec.*, 1932.—The influence of pressure on the amount of gas adsorbed by charcoal at 15°C has been measured for the gases SO_2, CH_3Cl, CO_2, N_2O, N_2, O_2 and H_2. Further the influence of temperature on the amount of gas adsorbed at 1 atmosphere pressure has been measured for the gases H_2, SO_2, CO_2, NH_3 and CH_4.

There appears to be a simple relation between the adsorbability of a gas at 15°C and the vapour pressure of the liquefied gas at the same temperature. A few preliminary experiments on the adsorption of gas mixtures have also been carried out. F. J. W.

816. Test of Adsorption Formulæ with Adsorption Measurements on a Highly Active Charcoal. E. L. Lederer. *Kolloid Zeits.* 61. *pp.* 323–328, *Dec.*, 1932.—The adsorption measurements used are those of Remy and Hene [see preceding Abstract]. The logarithmic and Langmuir isotherms are indistinguishable. The logarithmic isobar and the rule of Gurwitsch satisfy the results, while the Trouton-Poole rule is true only to a first approximation. The relation due to Polanyi has only a limited applicability. F. J. W.

817. Adsorption of Electrolytes by Ash-Free Charcoal. E. J. Miller. *J. Phys. Chem.* 36. *pp.* 2967–2980, *Dec.*, 1932.—A review. A detailed discussion of the oxide and gas electrode theories. F. J. W.

818. Action of Breathing Filters. H. Engelhard and K. Pütter. *Zeits f. Elektrochem.* 38. *pp.* 906–911, *Dec.*, 1932.—The action of breathing filters for both in and out breathing was investigated. The filters were packed with carbon, and in some cases absorbents of gases were used in addition. It was found that the passage of the outward gases brought about a very considerable amount of regeneration of the filter. Further the expelled carbon dioxide was absorbed to some extent, and increased the carbon dioxide content of the gases inhaled. It was concluded that the filters adsorbed the poisonous gases, or held them in loose combination. F. J. B.

See also Abstracts 834, 835, 836, 837, 838, 840, 907.

ATOMIC AND MOLECULAR STRUCTURE.

819. Mass Ratio of the Boron Isotopes from the Spectrum of BO. F. A. Jenkins and A. McKellar. *Phys. Rev.*, 42. *pp.* 464–486, *Nov.* 15, 1932.—New measurements are made of the rotational structure of the α bands of BO, and the wave numbers of the lines in the $^2\Pi_{1/2}$, $^2\Sigma$ component up to about $J = 20$ are tabulated for several bands of both the $B^{11}O$ and $B^{10}O$ systems. The vibrational isotope effect is considered, and values for the mass-ratio $B^{11} : B^{10}$ are obtained in agreement with Aston's value. Improved values are obtained for the vibrational constants of the $^2\Sigma$ and $^2\Pi_{1/2}$ states. From the rotational term-differences, the constants B_v and α are computed, also by least squares, and equations are given. The spin-coupling constant A is also evaluated by the 1, O band, and found to be the same for $B^{11}O$ and $B^{10}O$. G. G. S.

820. Physical Atomic Weights. F. W. Aston. *Chem. Soc., J. pp.* 2888–2904, *Dec.*, 1932.—This lecture consists of a review of the results of experiments on the isotopic constitution of atoms which have been achieved with the use of the mass-spectrograph. Special mention is made of the determination of atomic weights from measurements of the abundance ratios of isotopes and of the agreement between these atomic weights, determined physically, and the chemical atomic weights. J. E. K.

821. X-Ray Investigation of Normal Paraffins Near Their Melting Points. A. Müller. *Roy. Soc., Proc.* 138. *pp.* 514–530, *Dec.* 1, 1932.—The lattice constants of a number of normal paraffins

between $C_{19}H_{40}$ and $C_{44}H_{90}$ at various temperatures between 20°C and the melting points are recorded. The members between $C_{21}H_{44}$ and $C_{27}H_{56}$ inclusive, and $C_{29}H_{60}$ change from a state of lower symmetry to hexagonal symmetry at temperatures just below the melting points; $C_{18}H_{38}$, $C_{19}H_{40}$, and $C_{20}H_{42}$, and the members above $C_{29}H_{60}$ tend to approach hexagonal symmetry, but do not attain it below the melting point. For $C_{21}H_{44}$ and $C_{23}H_{48}$ the *a* and *b* axes change continuously as the temperature is raised from 20°C to the melting point, whereas for a number of other members, above $C_{23}H_{48}$, the axes change abruptly within this interval. The lattice energies of the paraffins change very rapidly with increase of molecular distance. Photographs obtained with the molten hydrocarbons exhibit a diffuse band, the observed spacings at the melting point being about 4·6 Å for $C_{18}H_{38}$ to $C_{30}H_{62}$. A qualitative explanation of the transition is developed. H. F. G.

822. Density and Molecular State of Gaseous Rhenium Tetrachloride and Rhenium Hexachloride. D. M. Yost and G. O. Shull. *Am. Chem. Soc., J.* 54. *pp.* 4657–4661, *Dec.*, 1932.—Carefully purified rhenium and chlorine confined in various atomic ratios in glass bulbs were heated to 600° for periods up to 14 hours. The colours of the resulting vapours showed that at least one constituent was present for all proportions of Re and Cl. Small black crystals which condensed in each case at room-temperatures were, when thin, red by transmitted light and were shown to be $ReCl_4$. Free chlorine could be seen in tubes containing more chlorine than was necessary to form $ReCl_4$. The products resulting from the ratio 1 Re : 6 Cl on cooling with liquid air and then attaining room-temperature gave a reddish yellow solid volatilisable by the warmth of the hand. The products resulting from the other ratios reacted with water to form a black precipitate. Those for the ratio 1 Re : 8 Cl gave a yellow solution in water which became rapidly colourless with the formation of perrhenic acid. The tubes were weighed before and after releasing the excess gases resulting from the heating, and with the aid of the volumes of the tubes and the weights of Re and Cl initially present the vapour densities were calculated. The results are explained on the basis that the polymerised and simple tetrachlorides exist in equilibrium, and in the presence of excess chlorine the hexachloride is also formed, all four substances being present in equilibrium. It is also deduced that Re_2Cl_4, Re_2Cl_6, $ReCl_7$ did not exist in the tubes under the conditions of the experiments. P. H. B.

823. Viscosity and Molecular Weight. E. O. Kraemer and F. J. van Natta. *J. Phys. Chem.* 36. *pp.* 3175–3186, *Dec.*, 1932.—The viscosity of polymers of ω hydroxydecoic acid, of the form $HO[(CH_2)_9COO]_xH$, has been measured with special attention to uniformity of each polymer and to the accuracy of the determination of its molecular weight. Titration of the terminal acid groups makes it possible to measure higher molecular weights than those of substances previously examined. The results so found agreed with those given by a physical method. The molecular weight and the specific increase of viscosity are related by a formula of the Staudinger type up to a molecular weight of 15,000. Above this, the observed viscosities are larger than the calculated. In the case of the highest molecular weight examined, 25,000, the viscosity falls slightly with increase of rate of shear. The work

indicates unreliability of Staudinger's determinations of very high molecular weights. A. S. C. L.

824. Relations of the Empirical Atom- and Ion-Radii to the Thomas-Fermi Charge Distribution in the Atom. W. Braunbek. *Zeits. f. Physik*, 79. 11–12. *pp.* 701–710, *Dec.* 30, 1932.—An attempt is made to relate the trend of the empirical atom and ion radii with the nuclear charge Z within a vertical column in the periodic system, as, *e.g.*, Li, Na, K, Rb, or Li^+, Na^+, K^+, Rb^+, Cs^+, etc., with the Thomas-Fermi charge distribution in the atoms and ions. It appears that a close approximation to the correct trend is obtained, if the effective radius is defined as the radius of a sphere, outside of which the Thomas-Fermi charge distribution gives a constant charge independent of Z. This charge differs somewhat for the various series but is in every case of the order of magnitude of one electron. J. E. K.

See also Abstracts 829, 992, 999, 1015, 1045, 1050, 1067, 1211.

COLLOIDS.

825. Ionic Interchange in Sulphur Sols. Lyotropic Series and Mechanism of Coagulation. T. R. Bolam and G. Bowden. *Chem. Soc., J. pp.* 2684–2694, *Nov.*, 1932.—Measurements of the adsorption of the ions of alkali-metal salts by the micelles in sulphur sols stabilised by a polythionic acid show that the lyotropic series occurs in the ionic interchange and also in the adsorption of total salt. The ionic interchange can be correlated with coagulative action, since it appears that, provided the concentration of acid in the system be not too high, coagulation takes place at that concentration of salt which just suffices to liberate the whole of the hydrogen ion. An interpretation of the results obtained is given in terms of the Donnan equilibrium and the theory of surface dissociation. T. H. P.

826. Nature of Coagulation Viscosity and Thixotropy in Colloidal Solutions. S. S. Kistler. *J. Phys. Chem.* 36. *pp.* 2948–2966, *Dec.*, 1932.—The existence of cybotactic complexes—associations of molecules into transitory groups—or " cybomas " is discussed and colloids are divided roughly into two classes corresponding with lyophobes and lyophiles, according to whether the surfaces tend to depress or stimulate the formation of such complexes. The stability of a lyophilic sol depends mainly on a concentration gradient of cybomas decreasing with distance from each colloid particle, whilst the tendency to coagulate and the previously postulated force of unknown origin tending to draw distant particles in lyophile sols together are connected with a gradient of opposite sign. On the basis of assumptions concerning the average size and life of cybomas, equations are derived showing the relatively great distance into a liquid at which a surface may have influence. The difference in case of dispersion between lyophile and lyophobe colloids and the unexpectedly high rate of diffusion of the former are explained. The tendency of lyophilic sols to uniformity of particle size is predictable from the interactions with cybomas, and the tendency of lyophiles to precipitate in fibrils, plates or " brush heaps " enclosing much liquid is a necessary consequence of the assumptions made, as also is the non-orientation of non-spherical particles in the plane of shear ; the direction of rotation and the influence of rate of shear and particle size are predicted.

The influence of a colloid on the viscosity of a liquid is ascribed to (*a*) the influence on the total number of cybotactic complexes, (*b*) the interaction between these complexes and a particle under shear, tending to increase the resistance of a particle to viscous flow, and (*c*) the interactions between two particles while passing, owing to intermingling of their attendant cyboma swarms. T. H. P.

827. Specific Conductivity of the Intermicellar Liquid of Gold Sols. R. Wintgen and W. Hacker. *Kolloid Zeits.* 61. *pp.* 335–344, *Dec.*, 1932.—Three methods have been investigated for obtaining the intermicellar liquid of formol-goldsols, *viz.*, ultrafiltration, equalisation, dialysis and centrifugalisation. The latter process afforded an immeasurably small value for the difference between the specific conductivity of sol and intermicellar liquid, *i.e.*, for the specific conductivity of the micellar portion. This result is in accord with the approximate value of the charge as calculated by v. Hevesy. By means of the centrifuge method, unprotected gold sols of relatively high gold content (up to 2·7 g. gold per 1,000 cc.) have been prepared, while the electrolyte content of the gold sol may be brought, within wide limits, to any desired concentration. In all cases the specific conductivity of the micellar constituent is infinitesimal. H. H. Ho.

828. Filtration of (Hydrophobic) Colloids. May Annetts. *J. Phys. Chem.* 36. *pp.* 2936–2939, *Dec.*, 1932.—Changes of electrical conductivity of arsenic sulphide and other sols are observed after filtration through filter paper. It is concluded that there is an increase of conductivity due to solution of electrolytes from the filter paper and a decrease due to adsorption of H ions by the paper. The result is changes in pH, conductivity and stability of sols by filtration. A. S. C. L.

829. Electrokinetics. Part XII. O. G. Jensen and R. A. Gortner. *J. Phys. Chem.* 36. *pp.* 3138–3151, *Dec.*, 1932.—The relationship between molecular structure and interfacial energy was investigated, using five normal aliphatic acids, an homologous series of the normal aliphatic alcohol esters of acetic acid and a series of ethyl esters of certain on the normal aliphatic acids, against aluminium oxide. A potentiometric method was employed for measuring the streaming potentials. The streaming potential was found to increase linearly with the pressure. The immobile side of the double layer was negatively charged for all the esters examined, with the exception of ethyl formate, and positively charged for the series of n-aliphatic acids. An alternating effect of the odd and even number of carbon atoms was observed on the ζ-potential and on the electric moment of the double layer. The investigation confirmed the view that streaming potential technique is applicable to the study of the structure of the organic molecule. F. J. B.

830. Correlation of Stream Potentials and Surface Conductance. H. L. White, F. Urban and E. A. van Atta. *J. Phys. Chem.* 36. *pp.* 3152–3156, *Dec.*, 1932.—The stream potentials with capillaries of 0·005mm. dia. were found to be from 0 to 25% as great as with large capillaries. Previous measurements gave 75 to 85% as great. The lower figures were not accounted for by the classical stream potential equation, or by any modification so far proposed. The correlation of surface conductance and stream potential was shown to be dependent upon the establishment of normal stream potential conditions. F. J. B.

831. Application of the Double Layer Theory of Otto Stern. Part 1. F. Urban and H. L. White. *J. Phys. Chem.* 36. *pp.* 3157–3161, *Dec.*, 1932.—The double layer theory of Otto Stern is discussed, and the distribution of ions in the Helmholtz and Gouy Layers is calculated for 5×10^{-4} *N* KCl and pyrex glass. It is shown that the ζ-potential and the surface conductance are related in dilute solutions. Evidence is obtained to show that the ions in the inner Helmholtz layer are mobile. F. J. B.

832. Structural Viscosity in Lyophilic Sols. W. Gallay. *Canad. J. of Research*, 7. *pp.* 662–676, *Dec.*, 1932.—Part I. Flocculation of gelatin and casein sols by agar. Deviations from the Poiseuille equation are shown by 1% gelatin sol and by 0·2% agar and by mixtures of these. Agar lowers the " viscosity " of gelatin ; this is ascribed to a dehydration. The imaginary " velocity of flow," defined as const. P/η, is discussed. Part II. Rubber sols in benzene also show deviations above a limiting concentration, which agrees with Staudinger's values. A. S. C. L.

833. Study of Gels by Physical Methods. E. Hatschek. *J. Phys. Chem.* 36. *pp.* 2994–3009, *Dec.*, 1932.—The paper describes a method not hitherto employed for obtaining Young's modulus, with applications to agar, silicic and formaldehyde-gelatin gels and a study of their variation with age. An investigation is also recorded into the changes produced by the reversible and irreversible deformation of gelatin in accidental birefringence, tensile strength and permeability to a solute, *i.e.*, diffusion velocity in the gel. Some theoretical complications of the experimental findings are discussed very briefly. H. H. Ho.

834. Films, Threads and the Science of Colloids. Wo. Ostwald. *Kolloid Zeits.* 61. *pp.* 136–140, *Nov.*, 1932.—From a general discussion of the knowledge of this subject, it is concluded that films and threads must be regarded as transition states between matter in the mass and matter resolved into molecules and atoms, *i.e.*, as transition states between the coarse, obvious discontinuity of bodies and their discrete analytical discontinuity. They are generally-possible forms of state and possess all degrees of difformation. Disperse and difformed systems, which must be classed together, are both characterised by enormous development of the specific surface if, starting from macroscopic discontinuity, discrete discontinuity is approached by dispersion or difformation. The problems for investigation in this field are discussed. T. H. P.

835. Films : Physics of Membranes. E. Manegold. *Kolloid Zeits.* 61. *pp.* 140–160 ; *Disc.*, 160, *Nov.*, 1932.—A summary of work published during the past two years. T. H. P.

836. Membrane Equilibria. F. G. Donnan. *Kolloid Zeits.* 61. *pp.* 160–167 ; *Disc.*, 167, *Nov.*, 1932.—The development of the theory of the membrane is outlined and its applications referred to, its importance in regard to physiological processes being given special attention. T. H. P.

837. New Investigations on Unimolecular Surface Films. N. K. Adam. *Kolloid Zeits.* 61. *pp.* 168–177, *Nov.*, 1932.—A summary is given of recent results in this field. T. H. P.

838. Investigations on Film Structures by Electrical and Optical Methods. E. K. Rideal. *Kolloid Zeits.* 61. *pp.* 177–180,

Sept., 1932.—A record is given of the work of the author, Schulman and Hughes on this subject during the past few years. [See also Abstracts 3265 (1930), 2072 (1931), 3468 (1932).] T. H. P.

839. Modified Electro Ultra-Filter. D. v. Klobusitzky. *J. Phys. Chem.* 36. *pp.* 3189–3190, *Dec.*, 1932.—The electro ultra-filter of Bechhold was modified in order to facilitate repairs and to avoid interruption of the work in hand, owing to lack of spare parts to replace breakages. The modified apparatus had a strong glass cylinder closed by a membrane of parchment as recipient, and a candle of any make could be employed. A current of 110 volts and 0–5 amperes was employed. F. J. B.

840. Theory of Emulsions. C. H. M. Roberts. *J. Phys. Chem.* 36. *pp.* 3087–3107, *Dec.*, 1932.—The problem of emulsions is restated in terms of ionic and molecular adsorption with special reference to naturally occurring petroleum/brine systems. The conclusions are mainly in agreement with the conception of ζ potentials. A. S. C. L.

See also Abstracts 823, 856, 1112, 1174.

CRYSTAL STRUCTURE AND PROPERTIES.

841. New Representation of Geometrical Crystallography. B. Delaunay. *Zeits. f. Krist.* 84. *pp.* 109–149, *Dec.*, 1932.—A formal scheme, embracing the following : 1. The Voroni range of a point lattice ; 2. Deduction of the seven systems ; 3. The Bravais parallelepiped ; 4. Numerical data ; 5. Reduction-theory ; 6. The twenty-four kinds of point-lattice symmetry, with applications to structure-theory ; 7. Graphical reduction by zones. There are also three Appendices. F. I. G. R.

842. Relation of Atomic Sizes to Interatomic Distances in Homopolar Crystals. G. W. Brindley. *Zeits. f. Krist.* 84. *pp.* 169–172, *Dec.*, 1932. *In English.*—The list of atomic radii calculated by Slater's method is extended and the results compared with the interatomic distances in a number of crystals in which the atoms are grouped tetrahedrally about each other. It is found that in proceeding from the SiC group of crystals to the AlN, ZnS and AgI groups the observed interatomic distances become increasingly smaller compared with the sums of the atomic radii. This is explained by the assumption that in crystals such as AlN for example, there exists, in addition to the homopolar type of binding, an electrostatic attraction between Al^- and N^+. J. T.

843. Metallic Films and Surfaces. K. Richter. *Kolloid Zeits.* 61. *pp.* 208–218, *Nov.*, 1932.—The structure, optical and photo-electrical properties, the electrical conductivity and the magnetic properties of thin metallic films are discussed. The technical applications are also considered. F. J. W.

844. Crystal Structure of Lead Bromide, $PbBr_2$. W. Nieuwenkamp and J. M. Bijvoet. *Zeits. f. Krist.* 84. *pp.* 49–61, *Dec.*, 1932.—The cell contains four molecules of $PbBr_2$ and has the following dimensions : $a = 4{\cdot}71_5$ Å, $b = 8{\cdot}02$ Å, $c = 9{\cdot}48_5 \pm 0{\cdot}01$ Å. Space group V_h^{16}. The structure is a new one for compounds of the form AX_2, and is intermediate between the structures CaF_2, TiO_2, $CdCl_2$, and those of the CdI_2 type. The high deformability of Pb is significant. F. I. G. R.

845. Crystal Structure of Lead Fluoride, PbF_2. J. A. A. Ketelaar. *Zeits. f. Krist.* 84. *pp.* 62–64, *Dec.*, 1932.—Dimensions of unit cell (containing four molecules): $a = 3{\cdot}80 \pm 0{\cdot}01$ Å, $b = 6{\cdot}41 \pm 0{\cdot}02$ Å, $c = 7{\cdot}61 \pm 0{\cdot}03$ Å. [See also preceding Abstract.] F. I. G. R.

846. Structure of Potassium and Ammonium Perchlorates. C. Gottfried and C. Schusterius. *Zeits f. Krist.* 84. *pp.* 65–73, *Dec.*, 1932.—These compounds are rhombic-bipyramidal, with space group V_h^{16}. The unit cell in both cases contains four molecules. The kation is surrounded by twelve O atoms, and each Cl by four O atoms (not forming a perfect tetrahedron). Numerical data as follows :—

	$KClO_4$	NH_4ClO_4
	$a = 8{\cdot}834 \pm 0{\cdot}006$ Å	$9{\cdot}202 \pm 0{\cdot}006$ Å
	$b = 5{\cdot}650 \pm 0{\cdot}004$ Å	$5{\cdot}816 \pm 0{\cdot}004$ Å
	$c = 7{\cdot}240 \pm 0{\cdot}005$ Å	$7{\cdot}449 \pm 0{\cdot}005$ Å
mean	O—O 2·36 Å	2·42 Å
	Cl—O 1·44 Å	1·49 Å

F. I. G. R.

847. X-Ray Investigations into the Change in Orientation of the Crystal Lattice Accompanying Modification of a Substance. H. Shôji. *Zeits. f. Krist.* 84. *pp.* 74–84, *Dec.*, 1932.—A discussion of corresponding crystal directions for the allotropic, or polymorphic, transitions in Fe, ZnS and $CaCO_3$. An appropriate mechanism is described. F. I. G. R.

848. Crystal Structure of Lithium Sulphate. J. G. Albright. *Zeits. f. Krist.* 84. *pp.* 150–158, *Dec.*, 1932. *In English.*—The compound is monoclinic, having a unit cell of dimensions: $a = 8{\cdot}25$ Å, $b = 4{\cdot}95$ Å, $c = 8{\cdot}44$ Å, $\beta = 107°{\cdot}54'$. Space group $C^5_{2h}(P2_1/_a)$. The S — O distance in (SO_4) tetrahedra is 1·50 Å and O — O = 2·45 Å. F. I. G. R.

849. Carbonate and Nitrate Groups in Calcite and Aragonite Types of Lattice. R. Reinicke. *Zeits. f. Krist.* 84. *pp.* 159–166, *Dec.*, 1932.—Assuming tetrahedral atomic domains the CO_3 and NO_3 radicals are investigated by space-geometry. In agreement with the assumptions hitherto made for reasons of symmetry it is found that the three oxygen atoms lie at the corners of an equilateral triangle, at the mid-point of which is the carbon or nitrogen atom. The possibility of explaining the existence of di- and trimorphous forms is discussed. J. T.

850. Structure of α-Zinc Hydroxide. W. Feitknecht. *Zeits. f. Krist.* 84. *pp.* 173–176, *Dec.*, 1932.—α-Zinc hydroxide can exist in a form isomorphous with the hydroxides of the other bivalent metals, and has C_6 symmetry. Only very few lines could be obtained on the powder photographs, and the cell size is given as $a = 3{\cdot}14$ Å, c uncertain but the mean value of the axial ratio is $c : a = 1{\cdot}63$. The polymorphism of zinc-hydroxide is due to the strongly polarising action of the zinc ions on the hydroxyl ions. W. H. Ge.

851. Crystal Structure of β-Arabinose. E. G. Cox. *Zeits. f. Krist.* 84. *pp.* 45–48, *Dec.*, 1932. *In English.*—Chemical and X-ray evidence shows that the molecule of β-arabinose is not an open chain. [See also Abstract 28 (1932).] F. I. G. R.

852. p-Chlorobromobenzene and its Congeners: Variate Equivalent Points in Molecular Lattices. S. B. Hendricks. *Zeits. f. Krist*, 84. *pp.* 85–96, *Dec.*, 1932. *In English.*—The following data are given for the unit cells of the compounds noted :—

Compound.	a	(d_{100})	b	c	β	No. of mols.
p-Dichlorobenzene .	14·83	13·70	4·10	5·88	112°30′	2
p-Dibromobenzene .	15·46	14·39	4·11	5·80	112°38′	2
p-Chlorobromobenzene	15·15	13·95	4·12	5·81	113° 9′	2

All are monoclinic prismatic. The dichloro- and dibromo-' compounds, though apparently isomorphous, have different structures; but the lattice of an equimolal solid solution of the two and that of the chloro-bromo-derivative, as regards the positions of the halogens, are closely similar. This, with the reflection intensities of this last lead to the conclusion that in it [space group C^5_{2h} $(P2_{1a}]$ the Cl and Br atoms are structurally equivalent, affording an example of variate equipoint structure. [See also Abstract 3325 (1931).] C. A. S.

853. Habit and Structure of Potassium Bitartrate. A. Ferrari and R. Curti. *Zeits. f. Krist.* 84. *pp.* 8–13, *Dec.*, 1932. In *Italian.*—Crystals of potassium bitartrate, obtained by slowly dropping acetic acid into a solution of sodium potassium tartrate, exhibit a habit which has not hitherto been observed. This is characterised by big prism faces and secondary development of the (100) face. If phosphoric acid is used, badly developed, twinned crystals are obtained. The unit cell has the dimensions $a = 7{\cdot}614$ Å, $b = 10{\cdot}70$ Å, and $c = 7{\cdot}80$ Å. It contains four molecules of $C_4H_4O_6KH$. The chain of carbon atoms in the molecule probably lies along the b-axis. J. T.

854. Twinning of Quartz. O. Mügge. *Zeits. f. Krist.* 84. *pp.* 97–108, *Dec.*, 1932.—Microscopical study of the twinning of quartz crystals found in magma with special reference to the temperature of formation. W. H. Ge.

855. Preparing Crystals for Rotation Photographs. H. Kersten and W. Lange. *Rev. Sci. Instruments*, 9. *pp.* 790–791, Dec., 1932.—An adaptation of a dental drill to hold and grind a crystal for X-ray diffraction. E. E. F. d'A.

856. Particle Size Determination by Electron Diffraction. M. v. Laue. *Zeits. f. Krist.* 84. *pp.* 1–7, *Dec.*, 1932.—The author discusses the work of G. P. Thomson on the determination by electron diffraction of the size of crystal fragments which instead of being randomly oriented are parallel to each other. J. T.

857. Precision Determination of Lattice Constants of Non-Cubic Substances. W. Stenzel and J. Weerts. *Zeits. f. Krist.* 84. *pp.* 20–44, *Dec.*, 1932.—A method is developed whereby a direct correction may be applied for all systematic errors. A flat film is employed and only the high angle reflections are considered. Lattice constants of non-cubic materials can be determined to an accuracy of about $\pm 0{\cdot}01\%$, *i.e.*, as accurately as those of cubic substances. New determinations are made of the lattice constants of Cd, Zn, Mg, Re and β-Sn. J. T.

858. Structure of Interference Lines in the Powder Method. I. Levin and E. Ott. *Zeits. f. Krist.* 84. *pp.* 166–169, *Dec.*, 1932. *In*

English.—The doubling of the inner lines of a powder photograph, due to the size of the specimen, which was predicted by Möller and Reis, has been observed by the authors in several cases, and is found to be in qualitative agreement with the prediction. J. T.

859. Structure of "Real" Crystals. E. Orowan. *Zeits. f. Physik*, 79. 9–10. *pp.* 573–582, *Dec.* 15, 1932.—Objections based upon the numerical calculations and upon the supposed generality of Zwicky's results. [See Abstract 318 (1932).] F. I. G. R.

See also Abstracts 821, 1000, 1023, 1102, 1113, 1120, 1170, 1191, 1207, 1208, 1209, 1212, 1213, 1217, 1235.

DENSITY.

See Abstracts 822, 901, 1029, 1131.

DIFFUSION AND OSMOSIS.

860. Rotation of Crystals Floating on Liquid Surfaces. P. Gaubert. *Comptes Rendus*, 195. *pp.* 1088–1090, *Dec.* 5, 1932.—Any crystalline or amorphous solid which is lighter or not much heavier than the liquid concerned (*e.g.*, aspirin, *d* 1·39, or acetanilide, *d* 1·211 on water) will rotate on the surface of such liquid provided that it is itself soluble, or is saturated with a substance soluble therein. The phenomenon as exhibited by crystals of isovaleramide, *d* 0·955, and thymol, *d* 1·035, are described. The movements are recoil effects due to diffusion currents from the dissolving substance. C. A. S.

861. Diffusion in Liquids. Part I. R. Fürth. Parts II and III. R. Zuber. Part IV. R. Zuber and K. Sitte. Part V. K. Sitte. *Zeits. f. Physik*, 79. 5–6. *pp.* 275–344 *Nov.* 26, 1932.—General considerations are dealt with in Part I. Some dilute solutions appear to obey Fick's law, but in more concentrated solutions the rate of diffusion is the sum of a series of terms, each proportional to a power of the concentration gradient. Several coefficients of diffusion are thereby defined for each liquid, and a twofold problem remains, *viz.*, to find the precise form of the diffusion law, and to determine the coefficients. Part II describes the apparatus. The liquids are contained in a narrow cell, one wall of which is a vertical side of a right-angled glass prism. A parallel beam of monochromatic light enters the hypotenuse of the prism normally, and is either refracted into, or totally reflected from the liquid in the cell. If the light enters the cell, it illuminates part of a ground glass slip which constitutes the narrow vertical wall of the diffusion chamber. The chamber is divided into two parts by a horizontal slip which separates the diffusing liquid from the solvent. When the plane is removed, diffusion begins, and is followed microscopically by the vertical progress of the patch of light on the ground glass screen. A series of observations may be taken in a short time. In Part III this method is used to investigate the diffusion of sugar, urea, glycerin, and formamide, as examples of non-electrolytes. Fick's law is never obeyed, but while the concentrations are not too high, the law of Boltzmann

$$\frac{\delta_c}{\delta_t} = \frac{\delta}{\delta_x}\left(\mathrm{D}\frac{\delta_c}{\delta_x}\right),$$

where c is the concentration, t the time, and x the distance, which measures the progress of the diffusion, accounts satisfactorily for the results. x is always a linear function of $\sqrt{t}$. The values of D for different concentrations are calculated, and the radii of the diffusing particles calculated

from Einstein's formula. In Part IV the diffusion of the following salts in aqueous solution is measured: LiCl, LiBr, NaCl, NaBr, NaI, KCl, KBr, KI. The Nernst formula for diffusion in electrolytes is based on Fick's law, and is inadequate. A revised formula, based on Boltzmann's law, is deduced, and the coefficients calculated for different concentrations. For very weak solutions the coefficient of diffusion decreases, and for stronger solutions increases as the concentration increases. This is probably due to the effect on a particle of surrounding ions of opposite sign. At greater concentrations, association sets in, forming neutral particles no longer retarded by their charged neighbours. The coefficients show a correlation with the atomic weights of the kations. In Part V, Born's theory of ionic mobility is extended to include the effect of the charged atmosphere round a particle. The dependence of mobility on concentration thus deduced agrees well with the observed variation of viscosity with concentration. Similarly extending the Nernst-Planck and Bjerrum theories of diffusion, formulæ are obtained for the coefficient of diffusion. The results of Parts III and IV are analysed, and the degrees of association of the ions in aqueous solutions of the salts used in Part IV are calculated. Remarks by **J. Zirkler.** *ibid.* 80. 5–6. *p.* 412, *Jan.* 31, 1933. J. P. A.

See also Abstract 839.

ELASTICITY AND PLASTICITY.

862. Torsional and Flexural Oscillations of a Monocrystalline Rod. E. Goens. *Ann. d. Physik*, 15. 4. *pp.* 455–484, *Nov.*, 1932. *From the Reichsanstalt.*—On the lines of W. Voigt's work the general theory is developed of flexural and torsional oscillations in a thin circular cylinder cut with any orientation from a single crystal. A convenient approximate method is then employed to solve the equations. Special application of the results is made to the problem of finding the moduli of longidudinal and torsional elasticity from observation of the frequencies of flexural and torsional vibrations respectively. **Errata.** *ibid.* 15. 8. *p.* 902, *Dec.*, 1932. J. P. A.

863. Thick Plate Loaded Uniformly. C. A. Garabedian. *Comptes Rendus*, 195. *pp.* 1369–1371, *Dec.* 27, 1932.—A summary of the solution of the problem of flexure of a thick rectangular plate loaded uniformly on one surface. Similar methods may be applied when the load is central, but in other cases the formulæ, already very complicated, become unmanageable. J. P. A.

864. Torsion and Flexure of Shafting with Keyways or Cracks. W. M. Shepherd. *Roy. Soc., Proc.* 138. *pp.* 607–634, *Dec.* 1, 1932.—The method of conformal transformation is employed to analyse the properties under torsion and flexure of shafts containing indentations or slits parallel to their axes. In most cases the stresses, the reductions in torsional rigidity and the distortions are worked out. J. P. A.

865. Study of Hooke's Law. A. Jaquerod and O. Zuber. *Helv. Phys. Acta*, 5. 6. *pp.* 423–444, 1932.—Bars of silver-steel and of electrolytic copper are subjected to small stresses not exceeding a few hundred kg/cm^2, and the corresponding elongations are measured by the variation brought about in the capacity of a cylindrical condenser. In a bar of steel, before reheating, Young's modulus decreases linearly for stresses

from 25 to 480 kg/cm², while after reheating for 12 hours at 600°C the modulus is constant. In both cases the elasticity increases with load for very small loads, and reaches a maximum value. In the case of copper, the elasticity is more nearly constant, but again shows a maximum for very small loads. Hysteresis and evidence of plasticity are observed in steel. J. P. A.

866. Compressibility of Eighteen Cubic Compounds. P. W. Bridgman. *Am. Acad., Proc.* 67. *pp.* 345–375, *Dec.*, 1932.—The linear compressibilities up to pressures of 12,000 kg/cm², and the mean thermal expansions over the range 30° C. to 75° C., are measured for the following substances, all of which crystallise in the cubic system, *viz.*: CaS, SrS, BaS, MgO, Cu_2O, As_2O_3, $Sr(NO_3)_2$, CuCl, CuBr, CuI, LiI, NaI, RbCl, CsF, CsCl, CsBr, CsI. The sample blocks required were generally obtained from powders by high compression in a mould. Differences in compressibility related to chemical differences are pointed out. In any one group, *e.g.*, the sulphides of the alkali earths, compressibillty increases with the atomic weight of the second element. An exception to this rule occurs with the cuprous halides at low pressures, where the compressibility of the bromide, which should be between those of the iodide and the chloride, is greater than that of the iodide. At higher pressures the normal order is restored. With RbCl a discontinuity in the volume occurs at about 1000kg/cm². The paper concludes with curves illustrating the regularities in the variation of compressibility with molecular complexity. J. P. A.

867. Measurement of Mechanical Properties of Binary Inorganic Salt Mixtures. K. Laybourn and W. M. Madgin. *Faraday Soc., Trans.* 28. *pp.* 857–866, *Dec.*, 1932.—Binary mixtures of salts, *e.g.*, $Pb(NO_3)_2$/$NaNO_3$, are heated above the melting point and run into moulds and cooled under standard conditions. Mixtures of different ratios of the salts are used, special notice being taken of the eutectic type. Experiments are made upon transverse breaking strength, compression strength and Brinell hardness figures. Annealing is found to make the results more constant but lower. It is known that the strength of common salt under water is greater ; this may account for mixed salts with surfaces exposed to the air having greater strength but being erratic. Specimens are freed from surface moisture and coated with oil, when reproducible results are obtained. Graphs show the various relations between the properties and composition. H. M. B.

868. Solid Viscosities of Metals. K. Sezawa and K. Kubo. *Tokyo Univ. Aeronaut. Research Inst., Report No.* 89. *pp.* 195–231, *Dec.*, 1932. *In English.*—Rectangular bars of duralumin, aluminium, copper and brass, 1 or 2 mm. thick, up to 3 cm. in width and 18 cm. in length, are rigidly clamped at one end in a mass of iron. A mirror at the free end acts as a load, and reflects a beam of light to a recorder. From the logarithmic decrement and the frequency of the flexural vibrations, the solid viscosities are calculated on the assumption that internal resistance is proportional to deformation velocity. The viscosities are of the order 10^6 c.g.s. units, and increase rapidly as the amplitude increases. J. P. A.

869. Viscosity, Elasticity and Plastic Strength of Flour-Dough. R. K. Schofield and G. W. S. Blair. *Roy. Soc., Proc.* 138. *pp.* 707–718, *Dec.* 1, 1932.—The time of relaxation t_r in flour-dough may be defined as $dt/d(\log_e S)$, where t is the time and S is the stress to which the dough is

subjected. In this way t_r need not be independent of stress. The relation between the period of application of the stress and t_r then determines how much of a deformation is elastic and how much plastic. Experiments exhibiting the decay of internal stress in dough under different conditions are described. The relaxation time depends, as in worked metals, upon the total deformation of the piece. Deductions as to the internal structure of the dough are discussed. J. P. A.

870. Transverse Vibrations of a Loaded Bar. K. Sezawa and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 903–910, *Dec.*, 1932. *In English.*—As an approximation to the theory of two and three-storied structures, the free flexural vibrations of a vertical elastic column, loaded with two, or three concentrated masses along its length, are found. The method employed is similar to one previously employed [see Abstract 60 (1933)]. J. P. A.

871. Elastic Vibrations of a Mass on a Flat Spring. M. Rössiger. *Ann. d. Physik*, 15. 6. *pp.* 735–740, *Dec.*, 1932.—The motion of a mass attached to a flat spring can be expressed as the superposition of two sinusoidal torsional vibrations. The axis of rotation and periods are calculated. Several interesting cases are discussed, and experiments show that for different masses the results are in good agreement with the general formula. H. M. B.

872. Critical Torsional Oscillations of a Rotating Accelerated Shaft. M. Biot. *Nat. Acad. Sci., Proc.* 18. *pp.* 682–689, *Dec.*, 1932.—A mathematical analysis is made of the motion of a shaft when a force is applied having a variable part which is a moment of constant amplitude $M(x)$ per unit length, distributed along the shaft and varying with a frequency proportional to the angular velocity. By means of Heaviside's expansion, the motion is found when there is a sudden application of the moment $M(x)$. In the analysis damping is neglected as this is partly viscous and partly due to internal friction of the material and is not accurately known. An example is taken of a crankshaft of a 6-cylinder, 2-cycle engine; the maximum critical amplitudes and the maximum torsional strain are calculated. H. M. B.

873. Improved Vibrograph and Applications. T. Tirunarayanachar. *Rev. Sci. Instruments*, 3. *pp.* 766–776, *Dec.*, 1932.—This paper deals with a simple form of vibrograph in which a spring drum controls the motion of the photographic plate and the slit width and length are adjustable. It is shown how the vibrograph can be used for rough comparisons of the frequencies of tuning forks, and for approximate determinations of the frequency of alternating currents (*e.g.*, a.c. mains) and of acceleration due to gravity (by the falling plate method). J. S. C.

874. Apparatus for Experimenting with Gaseous or Liquid Pressures up to 15,000 Kg./cm.^{2} at all Temperatures. J. Basset. *Comptes Rendus*, 195. *pp.* 1242–1245, *Dec.* 19, 1932.—In a previous article [see Abstract 1064 (1931)] the author described the study of gaseous and liquid pressures up to 25,000 atmospheres. A description, photograph and diagram of an apparatus is now given which allows ocular vision and photographic and kinematographic registration in an enclosure under pressure, gaseous or liquid, up to 15,000 kg./cm.^{2} for several hours. If necessary the temperature of the enclosure can be raised as high as 1500° C. The field

of useful view is 8 to 12 mm. linear, the enclosure itself being 20 mm. in diameter and 130 mm. long. Suitable precautions are taken to avoid accident to the observer. T. B.

See also Abstract 891.

GRAVITATION.

875. Normal International Gravity Tables. G. Cassinis. *Bull. géodésique, No.* 32. *pp.* 313–326, *Oct.–Nov.–Dec.*, 1931.—The values of gravity deduced from the international formula [see Abstract 762 (1931)] have been calculated to 4 and to 3 places of decimals for every 10′ from 0 to 90°, and the differences between these results and those deduced from the formulæ of Helmert and of Bowie are also tabulated for every degree. C. A. S.

876. Theoretical Gravity Tables according to the New International Formula. W. D. Lambert and F. W. Darling. *Bull. géodésique, No.* 32. *pp.* 327–340, *Oct.–Nov.–Dec.*, 1931.—The values of gravity have been calculated for every 10′ by means of the equation $g = 980{\cdot}632272 - 2{\cdot}586146\cos 2\phi + 0{\cdot}002878\cos 4\phi - 0{\cdot}000004\cos 6\phi$, deduced from the international ellipsoid of reference, checked for every degree by comparison with Cassinis' form of the international formula, $g = 978{\cdot}049\ [1 + (\beta - \alpha - \alpha\beta)\ \sin^2\phi]\ /\ \sqrt{(1 - e^2\sin^2\phi)}$, where $\log(\beta - \alpha - \alpha\beta) = 3{\cdot}2795699$. [See preceding Abstract.] C. A. S.

See also Abstracts 874, 903, 954, 955, 979.

HYDRODYNAMICS AND AERODYNAMICS.

877. Two-Dimensional Flow as a Variation Problem. G. Braun. *Ann. d. Physik*, 15. 6. *pp.* 645–676, *Dec.*, 1932.—When a compressible fluid flows through a nozzle symmetrical about its narrowest section, at speeds less than that of sound, the velocities at points symmetrically situated with respect to this section, are equal. When the velocity of sound is attained, however, distinct asymmetry ensues. Also the resistance experienced by a body moving through a stationary compressible fluid increases sharply at this speed. The fundamental hydrodynamical equation is formulated for a compressible, non-viscous gas, and is shown to be of elliptic type for velocities below, and hyperbolic type for velocities above, that of sound. By relating the equation to a simplified variation problem, the motion is analysed in general terms, and the method applied to two examples, *viz.*, the flow round a circular cylinder, and the production of stationary waves in gas flowing through a straight channel. The results for the former case agree with the experiments of Taylor, and from an extension of the second case, an account of the variation of the velocity of sound with its velocity amplitude is deducible. J. P. A.

878. Flow in a Curved Pipe and its Stability. O. Miyagi. *Imp. Acad. Tokyo, Proc.* 8. *pp.* 352–353, *Oct.*, 1932. *In English.*—Equations are derived for the distribution of velocities over the cross-sectional plane containing the axis of the pipe by an approximate indirect method in which the pipe is regarded as a combination of cylindrical annular channels. H. F. G.

879. Equation of Motion of a Viscous Fluid Accompanied by a " Microgyrostatic " Field. S. Watanabe. *Phys. Math. Soc., Japan,* VOL. XXXVI.—A.—1933.

Proc. 14. *pp.* 570–578, *Nov.*, 1932. *In English.*—The tensor equation of motion of a viscous fluid is modified by the introduction of terms attributable to the presence of minute gyrostatic rotating portions in the fluid.
J. S. G. T.

880. Transitory Régimes. C. Camichel. *Comptes Rendus*, 195. *pp.* 1200–1202, *Dec.* 19, 1932.—The work of Crausse and Baubiac on phenomena characterising the period of establishment of the steady state of liquid flow in a cylindrical tube and past a circular obstacle, and the work of the author together with Escande and Dupin relating to the establishment of vortex motion are briefly referred to. Reynold's law of similitude is found to apply to the phenomena. J. S. G. T.

881. Fluid Flow Past an Obstacle. R. Thiry and L. Sackmann. *Comptes Rendus*, 195. *pp.* 759–762, *Nov.* 7, 1932.—Describes apparatus designed for studying the flow of water between two parallel smooth planes when the flow is obstructed by obstacles of various shapes and dimensions. The particular obstacle used in the work described in this paper was a cylinder 10 mm. high. The velocity of the water was about 10 cm./sec. and the forms of the stream lines observed are shown in a diagram.
J. W. T. W.

882. Sensitive Recording Altimeter and Thermometer for Aircraft. P. Idrac. *Comptes Rendus*, 195. *pp.* 761–762, *Nov.* 7, 1932.—Describes the construction of a registering precision altimeter based on the principle of the statoscope (with heavy thermal lagging). The thermometer is a fine nickel spiral incorporated in a Wheatstone bridge. The method of registration is photographic in both instruments. J. W. T. W.

883. Moment of the Force Acting on a Flat Plate Placed in a Stream between Two Parallel Walls. S. Tomotika and M. Inanuma. *Phys. Math. Soc., Japan, Proc.* 14. *pp.* 543–569, *Nov.*, 1932. *In English.*—It is shown mathematically that the moment of the force acting on a flat plate placed obliquely in an irrotational stream of incompressible fluid is always increased by the presence of the channel walls. The variation of the moment in the case of a Rayleigh disc, due to change in the ratio of the diameter of the disc to that of the tube in which the disc is arranged, is discussed. J. S. G. T.

See also Abstracts 973, 976.

KINETIC THEORY OF MATTER.

884. Brownian Movement Limits for Series of Observations. F. Zernike. *Zeits. f. Physik*, 79. 7–8. *pp.* 516–528, *Dec.* 3, 1932.—Mathematical methods for reducing the possible error of measurements made with instruments subjected to the influence of possible Brownian movements, *e.g.*, galvanometers, fluxmeters, etc., are discussed. J. S. G. T.

885. Experimental Study of the Time Course of the Brownian Motion of a Torsional Pendulum. E. Kappler. *Ann. d. Physik*, 15. 5. *pp.* 545–567, *Dec.*, 1932.—The author subjects the photographic records of the displacement of the pendulum as a function of time, obtained in previous work [see Abstract 330 (1932)], to further statistical analysis. By using in turn as time-origin all instants for which the displacement has a selected value x_0 the mean displacement $\bar{x}$ and mean square displacement $\overline{x^2}$ are obtained as functions of time t and x_0. When the pendulum is in

the condition for aperiodic motions, the theoretical requirement that the displacements x should form a Gaussian distribution about $\bar{x}$ for any time t positive or negative, is verified. For the case of a periodic motion, $\bar{x}$ and $\overline{x^2}$ are determined for initial displacements at which the initial velocity u_0 is (*a*) positive, (*b*) negative, and in this way $\overline{u^2}$ the equipartition value of the mean square velocity is arrived at. Using the equation $\overline{mu^2} = kT$, a determination of k by a method independent of that previously used is obtained. Characteristic features in certain of the experimental displacement curves are shown to be attributable to external vibrations.

W. S. S.

See also Abstracts 1116, 1156.

LENGTH (STANDARDS, MEASUREMENTS, APPARATUS).

886. Axial Arrangement for the Measurement of Length by the Interference of Light. J. Stulla-Götz. *Zeits. f. Instrumentenk.* 52. *pp.* 521–524, *Dec.*, 1932.—A Michelson interferometer, illuminated with parallel white light, carries a half-silvered, plane-parallel glass plate in one path. The multiple reflections arising in this path enable optical multiplication of length to be performed by a simple process in which the mirror in the other path is used as an auxiliary to increase by 3 times the original separation of the mirrors in the first path, using the central fringe of the group of fringes in white light as an indicator. By repeated operations of this procedure the original mirror separation in the first path may be multiplied as often as desired. The maximum factor possible in one step is limited to 3 in the arrangement described, but the possibility of using higher factors is to be investigated. Since the method utilises beams which are normal to the mirrors, it possesses advantages over earlier methods described by Väisälä and by Watanabe and Imaizumi.

H. B.

887. Reichenbach Method of Indirect Measurement of Length. T. Eversmann. *Zeits. f. Instrumentenk.* 52. *pp.* 525–528, *Dec.*, 1932.—The principal error in the optical method of length measurement due to Reichenbach arises in estimating the position of the two horizontal " distance " wires, fixed in the focal plane of the theodolite eyepiece, with respect to the horizontal graduation lines on the distant scale or staff, which is viewed through the telescope. To overcome the difficulty of estimation, a plane-parallel glass plate is supported in front of the objective (or between objective and eyepiece) in such a manner that the image of the distant scale can be displaced vertically by means of a measured rotation of the glass about a horizontal axis. This modification enables the positions of the " distance " wires to be accurately measured with respect to the adjacent graduation lines. The effect of a small error of parallelism in the glass plate is calculated and discussed. For lengths ranging from 5 to 35 m., the average error of measurement by the modified method corresponds to 1 part in 2,500 of the measured length. H. B.

MATHEMATICAL METHODS. THEORY OF MEASUREMENTS. UNITS AND DIMENSIONS.

888. Polydromes of the Newtonian Potential of a Family of Homogeneous Bodies. R. Wavre. *Comptes Rendus*, 195. *pp.* 1238–1240, *Dec.* 19, 1932.—The following theorem is set out and shown to be

true mathematically. The Newtonian potential of a homogeneous body, limited solely by the portions of the plane or spherical surfaces, is only a branch of a harmonic multiform function ψ. This latter allows an infinite number of determinations which change from one to the other as one traces the lines around the edges of the body. The function ψ allows, apart from these branching lines, only the polar singularities in the whole of the real space. R. S. R.

889. Practical Application of Periodogram Analysis. J. W. Sandström. *Gerlands Beitr. z. Geophys.* 38. 1. *pp.* 64–65, 1933.—When a series of observations has been brought into an analytical form by a Fourier series method extrapolation is a lengthy and wearisome procedure. Lindquist has supplied a simplified procedure by grouping and displacement of the observational material to obtain a curve which saves much time and gives a much better fit to the observations. The result is illustrated by the use of 124 years' observations of the Wener Lake which has an area of 5500 km^2. This lake has a small annual oscillation but it shows clearly two periods of 11·15 and 11·86 years, the time of oscillation of Jupiter's planets. The calculated curve fits the observations with an accuracy not hitherto attainable. R. S. R.

890. Summation Methods in Smoothing Curves. F. Vercelli. *Com. Naz. Italiano, Geod. e Geophys. Boll. No.* 8. *pp.* 129–133, *Aug.*, 1932.—In analysing a series of observations or replacing such a series by a smoothed set in order to eliminate abrupt irregularities, a common practice is to replace an observed ordinate γ_m by the average of a symmetrical series of pairs of ordinates on either side of γ_m, taken at uniform intervals on the abscissa axis. In other cases, some linear combination of the adjacent ordinates of the form

$$a_0\gamma_m + a_1(\gamma_{m-1} + \gamma_{m+1}) + a_2(\gamma_{m-2} + \gamma_{m+2}) + \ldots + a_n(\gamma_{m-n} + \gamma_{m+n})$$

may be used to replace γ_m and give a smoothed series. The danger of using formulæ of this type in analysing observations for periodicities is often not realised. In particular, where the simple mean of N consecutive equidistant ordinates is employed, any harmonic oscillation of the periods N, N/2, N/3 etc., is suppressed in the smoothed series. Averaging of this type is only applicable when component oscillations of periods at least five times the interval covered by N are present. Preferable methods of smoothing, which have not this tendency to suppress short-period oscillations have been given by the author in a previous paper [see *Analisi delle periodicita nei diagrammi, Atti* 1*st. Naz. delle Assicurazioni*, III, 1930]. E. L. J.

891. New Galton Apparatus for the Solution of the Partial Equations $\Delta U = 0$ and $\Delta U = C$. F. Bernstein. *Zeits. f. Physik*, 79. 9–10. *pp.* 684–695, *Dec.* 15, 1932.—This paper describes an adaption of the author's development of Galton's board [see Abstract 4054 (1932)]. The apparatus consists of two boxes, the bases of which are arranged to slide and which contain a number of cells. Each cell is graduated along its depth. To use the apparatus each cell is filled with sand to a height which will represent the ordinates of the function. This box is placed over the other but rotated in a horizontal plane through 180° relative to it. By removing the sliding base the sand falls through into the cells of the other box and by this operation the function has been transformed. The paper contains a number of examples of the use of this apparatus and an account of various developments of the method with particular reference

to the numerical solution of the equations $\Delta U = O$ and $\Delta U = C$. Two special applications are described, *viz.*, (1) the solution of $\Delta U = O$ for varying boundary conditions and (2) a calculation of the turning moment due to the torsion of a girder of T section. J. E. R. C.

See also Abstracts 841, 1198.

MECHANICS, QUANTUM.

892. Physical Principles of the Quantum Theory. G. Temple. *Roy. Soc., Proc.* 138. *pp.* 479–494, *Dec.* 1, 1932.—The principles of the quantum theory are reformulated as a sequence of propositions which are either summary statements of experimental procedure or hypotheses concerning experimental results and having an immediate physical interpretation. Operators representing actual processes of measurement and actual transformations of systems of measurement are given priority over operators representing physical variables. It is shown that quantum states are represented by certain selective processes represented by operators satisfying the condition $P^2 = P$. The only two necessary hypotheses are that under specified conditions there is a definite probability of transition from state P to state Q, and that this probability is the same for the transitions $P \rightarrow Q$ and $Q \rightarrow P$. Association of congruent transformations with unitary operators leads to a theory of dynamically conjugate variables, and completes the theory of the effective value of a variable averaged over all systems in a definite state. H. F. G.

893. Free Electrons in a Crystalline Lattice. Wave Equation and Magnetic Properties. L. Brillouin. *J. de Physique et le Radium*, 3. *pp.* 565–581, *Dec.*, 1931.—The method of self-consistent fields discussed in a previous paper [see Abstract 4817 (1932)] is corrected slightly and applied to the discussion of electrons in a metallic lattice. Bloch's formula is derived [see Abstract 784 (1930)] and amplified by the additions of terms which are of significance only in the case of very small crystals. The necessary modifications of the theory conditional upon the consideration of a reticular distribution of positive charges is very briefly discussed.

J. S. G. T.

See also Abstracts 1047, 1166.

RELATIVITY AND ETHER.

894. Formulæ for Apparent Displacements of Stars by the Sun's Gravitational Field. N. Stoyko. *Bull. Astronomique*, 7. 7. *pp.* 313–319, 1932.—Nine possible formulæ, giving the deflection of a ray of light passing the sun's limb at a known distance from its centre, were tried to see which gave the least residual errors. The observations of the Greenwich (1919), the Lick (1922) and the Potsdam (1929) expeditions were used. The formula finally adopted gave a weighted mean for the deflection of $1{\cdot}930'' \pm 0{\cdot}054$. G. C. McV.

SOLUTION.

895. Classical Ionisation Theory. G. Tammann. *Zeits. f. phys. Chem.* 163. *Abt. A.* 1. *pp.* 17–32, *Dec.*, 1932.—Theoretical. It is shown that heat is absorbed during ionisation owing to the change of internal pressure, and that the complete ionisation of salts and strong acids is rendered evident by the influence of pressure on the conductivity. The heat of

ionisation of water may be calculated from the change of internal energy of an aqueous solution of an acid or base on neutralisation, and the observed heat of neutralisation ; the decrease of the latter with rise of temperature is due to the change in the solvent. The volume change which occurs when a solution of a strong base is neutralised results from the change of internal pressure, and not from the formation of water from its ions ; the temperature coefficient of the volume change corresponds with the compressibility of water. Since " corresponding " solutions are characterised by having the same internal pressures, the concentrations of isohydric and " corresponding " solutions are in general different, and heat and volume changes therefore occur when isohydric solutions are mixed. H. F. G.

896. Theory of Rate of Solution of Gas in Liquid. S. Miyamoto. *Chem. Soc. Japan, Bull.* 7. *pp.* 388–398, *Dec.*, 1932. *In English.*—The new theory explains variation with concentration (of the reacting substance) in rate of solution of a gas in a reacting medium (*e.g.* of O_2 in solution of Na_2SO_3) better than the diffusion layer theory. From the general equation the solubility of a gas is determined as

$$\frac{1000pe^{-M\ (u_o^2-u_o'^2)/RT}}{RT},$$

the values of u_o u_o' for oxygen at 15° as 1·65 and 1·49 × 10^5 cm./sec. respectively, and Henry's law deduced. The distribution of a substance between two liquid phases treated on similar lines gives a law of form similar to that deduced by the method of thermodynamic potential. [See Abstract 2616 (1932)]. C. A. S.

897. Influence of Anions on the Velocity of Solution of Zinc. E. Müller and J. Förster. *Zeits. f. Elektrochem.* 38. *pp.* 901–906, *Dec.*, 1932.—The velocity of solution of zinc in a number of different acids was determined by measuring the volume of hydrogen evolved when the amalgamated zinc was brought into contact with the acid. A platinum wire was connected to the zinc rod to form a galvanic couple. In some cases the velocity of solution and the conductivity of the acids were parallel ; on other cases this was not the case. The reaction velocity was proportional to the current strength of the short-circuited element, since the hydrogen was evolved from the platinum surface. An incubation period was not observed. F. J. B.

898. Influence of Pressure on the Solubility of Ammonium Nitrate in Water at 25°. L. H. Adams and R. E. Gibson. *Am. Chem. Soc., J.* 54. *pp.* 4520–4537, *Dec.*, 1932.—From new experimental data on the specific volumes of solutions of ammonium nitrate over the whole range of concentrations at 25° C. and 1 atmosphere pressure, and direct measurements of the compressions of these solutions, the partial volumes of ammonium nitrate and water in different solutions under pressures from atmospheric to 10 kilobars have been calculated. The partial volumes of the salt do not exhibit the large increases with rising pressure observed with sodium chloride and potassium sulphate solutions ; with the 15 % solutions a slight increase is observed at low pressures. Above 15 kilobars the partial volume in solutions containing more than 15 % of the salt appears to be independent of the concentration. The solubility curve of the salt, the freezing curve of ice and the equilibrium diagram for the

system NH_4NO_3 — H_2O under pressure are shown. The solubility of the salt decreases continuously from 67·6 % at atmospheric pressure to 43·6 at 5 kilobars, 29·7 at 10 kilobars, and 25·3 at 12·1 kilobars, the eutectic pressure. T. H. P.

SURFACE TENSION AND COHESION.

899. Influence of Disturbing Factors and Temperature on Liquid Drops on the Surface of the Same Liquid. L. D. Mahajan. *Zeits. f. Physik*, 79. 5–6. *pp.* 389–393, *Nov.* 26, 1932.—Impurities on the surface of the liquid prevent the formation of liquid drops. This has been proved by dusting the surface with lycopodium powder or by spreading a thin layer of oil on the surface. The introduction of impurities to the mother liquid, or to the surrounding medium, render the formation of liquid drops more difficult and any drops formed are very unstable. An electric discharge diminishes the stability of the drops. Temperature influences different liquids in different ways and the effects produced on soap solutions, water, solutions of inorganic substances, viscous and mobile liquids, and oils and fats are recorded. [See also Abstract 2058 (1929.)] W. R. A.

900. Surface Tension of Mercury in a Silica Apparatus. R. S. Burdon. *Faraday Soc., Trans.* 28. *pp.* 866–876, *Dec.*, 1932.—Experiments are carried out to obtain the surface tension of mercury in vacuum under the best conditions for purity and accuracy of measurement. A large drop is used in a silica apparatus and Worthington's corrected formula applied. The value of the surface tension found is 488 dynes/cm., which is the same for a drop freshly formed in air. The temperature drop is 0·23 dyne per degree and remains constant to 230° C. Gases appear to have an action on the surface, but experimental proof is not yet available to support the theory of re-arrangement on the surface layer due to adsorption. H. M. B.

901. Parachor of Rhenium. H. V. A. Briscoe, P. L. Robinson and A. J. Rudge. *Chem. Soc., J. pp.* 2673–2676, *Nov.*, 1932.—Results of measurements of surface tension and density of rhenium dioxytrichloride, heptoxide, and trioxymonochloride give, for the parachor of rhenium, the respective values 78·9, 68·9 and 76·4. Most value is attached to the last of these. T. H. P.

902. Adhesion Tension. Receding Contact Angle, Pressure of Displacement Method. F. E. Bartell and C. E. Whitney. *J. Phys. Chem.* 36. *pp.* 3115–3126, *Dec.*, 1932.—The adhesion tensions were determined with the liquid reaching equilibrium after definitely receding in the pores of Ottawa sand packed in a standard manner. The apparatus is described and is essentially similar to that previously used. The method proved rapid in use. The apparatus was standardised for water-air, water-benzene, and water-nitrobenzene systems. The contact angle was determined for several organic liquids using air-organic liquid systems and hence the adhesion tensions were calculated. Water was then used in conjunction with these organic liquids, and hence its adhesion tension was determined. Finally, the adhesion tensions of several organic liquids forming zero contact angle were determined using water-organic liquid systems. For contact-angle forming liquids the results are in

agreement with those previously obtained by similar and by capillary tube methods. For water and for liquids the calculations for which involve water the results are in agreement with those of capillary tube observations, but are appreciably lower than those previously obtained by pressure of displacement methods using silica (tripoli). It is concluded that the surface properties of the silica (tripoli) originally used differ from those of fused quartz and sand. The work of adhesion of organic liquids against silica is shown to be about 1·1 times that of the same liquids against water. P. H. B.

See also Abstracts 813, 834, 835, 836, 837, 838, 860, 908.

TIME (STANDARDS, MEASUREMENTS, APPARATUS).

903. Recording the Falling Time of Bodies. R. M. Bowie. *Rev. Sci. Instruments*, 3. *pp.* 792–793, *Dec.*, 1932.—Describes an apparatus for measuring the time of fall of a ball on to a switch below, and recording it by an electrolytic method. The timing device proper consists of two styli which are fastened to an insulating handle with a space of about half an inch between them. In making a record they are drawn by hand across a sheet of mimeograph paper soaked in one of two recording solutions, one a solution of KI, the other of potassium ferricyanide and NaCl. While the current is flowing in the timing circuit, an alternating potential is set up between the two moving styli. If the solution which contains potassium iodide is used, iodine will be deposited under one stylus when it is positive, but during the next half cycle the iodine will be deposited under the other stylus. Spots are thus made alternately by the two styli at the rate of 120 per second. The total number of spots produced while the ball is falling divided by 120 is, then, the time of fall in seconds. E. E. F. d'A.

904. Effect of Tremors on the Rate of a Watch. J. Granier. *Comptes Rendus*, 195. *pp.* 1224–1225, *Dec.* 19, 1932.—When a watch is subjected to sinusoidal vibrations the amplitude of the balance wheel is diminished and the watch loses time. The former effect is due to an increase in friction, and the amplitude a of the balance is related to the amplitude α of the vibrations by the formula $a = A/(B + \alpha f^2)$ where A and B are constants and f is the period of the vibration to which the watch is subjected. This was confirmed experimentally. The other effect is not directly due to the increase in friction, nor is it due to the decrease in amplitude of the balance. It can only be due to the hair-spring, which, under the action of shocks or vibrations, may be considerably deformed, and the deformation is greater if the period of oscillation of the hair-spring approaches that of the vibrations to which the watch is subjected. It is pointed out that the frequency of flat spiral springs of the dimensions usually found in horology is 30 to 50 per second, which is of the same order of magnitude as the frequency of many petrol engines. J. S. C.

VACUA, HIGH.

905. Automatic Töpler Pump. A. T. Williamson. *Rev. Sci. Instruments.* 3. *pp.* 782–789, *Dec.*, 1932.—The author modifies the Töpler pump by employing compressed air as the source of power, and controlling its application through automatic valve systems. The new pump resembles the Stock pump in its more general features but differs radically

in that the floating valve has been replaced by one which is operated electrically by a new automatic control system. E. E. F. d'A.

VISCOSITY. FRICTION AND LUBRICATION.

906. System Water-Phenol: Part II. Viscosities. O. R. Howell. *Faraday Soc., Trans.* 28. *pp.* 912–928, *Dec.*, 1932.—Viscosity–concentration curves determined with the same solutions and for the same temperatures are very similar to the density–concentration curves [see Abstract 5322 (1932)]. Deviations from the linear mixture law indicate the compound PhOH, H_2O. Viscosity—temperature curves are smooth and accurately represented by Slotte's equation $\eta_t = S(t + k)^n$, where S, k, n are constants varying with concentration, plotted against which all three likewise indicate the compound PhOH, H_2O, as also do, when similarly plotted, the constants α and β of the fluidity equation, $\phi_t = \phi_o (1 + \alpha t + \beta t^2)$. T_c being the temperature at which the viscosity of a solution of concentration c is the same as that of one of concentration 75 % PhOH at T_{75} the ratio T_c/T_{75} plotted against T_c gives a series of horizontal straight lines. Changes of relative viscosity of PhOH and its solutions with temperature are anomalous. Batschinski's relation between viscosity and specific volume is only a form of Slotte's equation, as also is Macleod's relation between viscosity and free space [see Abstract 13 (1926)]; the latter gives results in good agreement with experiment. Mean viscosity at $t°$ is accurately $28{\cdot}88/(t + 30)^{1{\cdot}782}$, except near the critical solution temperature; the critical solution viscosity is 0·0085. C. A. S.

907. Physical Properties and Structure of Films of Lubricant. V. Vieweg. *Kolloid Zeits.* 61. *pp.* 198–208, *Nov.*, 1932.—A review. F. J. W.

908. Boundary Lubrication by Soap Solutions. R. C. Williams. *J. Phys. Chem.* 36. *pp.* 3108–3114, *Dec.*, 1932.—The value of various soap solutions as lubricants in wire drawing was examined by measuring the pull on the die. Owing to the high pressure it is assumed that "boundary lubrication" occurs. As the pH of the solution is increased, its lubricating power falls off; therefore it is concluded that the lubrication is due to hydrolysed fatty acid or to acid soaps. Tallow emulsified in the soap solution has little effect. The surface tensions of the solutions used were measured by a static method and their relation to the lubrication results discussed. The wire to be lubricated was in contact with the soap solution for less than 2 sec. A. S. C. L.

See also Abstracts 823, 826, 832, 868, 869.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

909. Franklin Institute Eclipse Expedition. J. Stokley. *Frank. Inst., J.* 214. *pp.* 735-746, *Dec.*, 1932.—The optical and other equipment for the long focus solar telescope (consisting of a coelostat with two mirrors reflecting the sun's light down a vertical shaft from the roof and a lens of 85 feet focal length, giving a 9-in. solar image on the floor) were not ready in the summer of 1932, so that the coelostat and accessories were available for the Ausust 31 eclipse work at a station (Conway) in New Hampshire. Cameras for it were constructed and smaller lenses installed to work off the coelostat, including a motion picture camera. Marian Eppley provided and operated a pyrheliometer equipment for radiation measurement; there was a programme for measuring sky illumination and the photography of shadow bands. Clouds prevented any results other than that the pyrheliometer records showed "a decrease in radiation to approximately that of night time, during totality." A. S. D. M.

See also Abstract 1030.

COMETS AND METEORS.

910. Definitive Orbit of Comet 1911b (Kiess). L. Lindsey. *Astron. J. No.* 983. *pp.* 109-117, *Dec.* 23, 1932.—This comet was discovered on a plate taken by Kiess at Lick Observatory on July 6, 1911. Preliminary elements were computed and published, and as they resembled those of Comet 1790 I, discovered and observed by Caroline Herschel, it was of interest to compute the orbit precisely from all available observations. The result shows that the two comets probably belong to the same family, but, since the orbit of Kiess' comet is too eccentric for it to have a period as short as 122 years, they cannot be identical. M. A. E.

911. Orbital and Velocity Variation of Halley's Comet and Its Distance from Perturbing Planets. A. Cabreira. *Comptes Rendus*, 195. *pp.* 1379–1381, *Dec.* 27, 1932.—The dates of passing perihelion indicate that Halley's comet has irregular periods. The lengths of the 1st, the 10th (the largest), the 14th (the mean) and the 28th (the least) are respectively 77^y5^d, 79^y132^d, 76^y255^d and 74^y183^d. The resulting variations of orbit and velocity are due to perturbation by the major planets. Taking these two variations separately the author finds for constant velocity $Jn = (1 \pm \Delta/79^y5^d) \times Ji$ where Jn, Ji and Δ are the given revolution, the first one, and the difference between these. For constant orbit, he gets $a = +A \times \delta/802$; $r = -R \times \delta/972$; $d = l \times \sqrt{A/a}$; $D = L \times \sqrt{R/r}$; where δ is the difference between the mean and any given period, a and r are the corresponding acceleration and retardation, A and R their maximum values, 802 and 972 the differences in days between the mean and the greatest and least periods, d and D the distances of the comet in each of the cases considered, and l or L those in the revolutions whose lengths are the limiting observed. From these the author constructs a table giving the lengths of the revolutions and the variations of the orbit, of the velocity and of the distance. A. S. D. M.

912. Origin of Continuous Cometary Spectra. W. M. Cohn. *Astrophys. J.* 76. *pp.* 277–285, *Dec.*, 1932.—Various theories concerning the origin of the continuous spectra of comets are discussed. The solar-type spectrum may be explained by the reflection of sunlight from large particles. Laboratory experiments show that continuous spectra may be produced by bombardment of ions of different materials with electrons in a high vacuum. A theory is developed which assumes that electrons are emitted constantly from the sun. These electrons will give rise to the violet type and, in the tail at a great distance from the head, to the solar type of continuous spectra observed in comets. The polarisation phenomena of the light emitted by comets are explained by the new theory. The continuous spectra of straight and curved tails are expected to differ in the shift of the maximum with growing distance from the head. Band and line spectra observed in comets are assumed to be mainly excited by electrons emitted constantly from the sun. AUTHOR.

913. Ephemeris of Leonid Meteors Radiant Point. A. King. *Roy. Astron. Soc., M.N.* 93. *pp.* 109–111, *Nov.*, 1932.—An inquiry into the motion of the radiant point (which should, theoretically, shift eastwards by about 1° per day) based on the author's observations of the years 1899–1904 and 1920–1931. The date, position, number, diameter of radiant, and weight are given for these years, and parabolic orbits computed for the centres; the dates of the showers are corrected for precession to 1932. There appears to be confirmation (though small in extent) in these positions for the slight shift which the author had observed in 1920, 1928, 1930 and 1931. The moving radiant shows 9° 41′ as its latitude, which is assumed to be maintained, and from this and the observed shift of 1° per day, the author computed an ephemeris for the days Nov. 12–15, 1932, Greenwich midnight. A. S. D. M.

914. Determination of Meteoric Trajectories. V. G. Siadbey. *Comptes Rendus*, 195. *pp.* 1232–1234, *Dec.* 19, 1932.—Instead of the classical method of Galle and Niessl, the author suggests a graphical method which does not involve least squares. For the final point of the meteor, from the geographical co-ordinates (λ_i, ϕ_i) of the terrestrial spot L_i (reduced to those seen at a certain spot L), can be obtained d_i (linear distance between L and L_i), Δ_i and H_i (declination and hour angle), r_i and ϕ_i, r and ϕ (distances and geocentric latitudes of L_i and L). From the sidereal time of observation at L there is found the R.A. at L_i; and $R_i = T - H_i$. A gnomonic projection is made of the celestine sphere for L's horizon, and on this chart is laid down the points R_i, Δ_i, thus obtained. A great circle passes approximately through the apparent trajectories of L and L_i and the R_i, Δ_i. The same is done for all L_i observations, and the process is repeated until the most consistent values are obtained. These corrected apparent trajectories can then be employed to calculate the elements of the real trajectory. For Bolides the initial as well as the final points must be used and corrected in a similar manner. A. S. D. M.

915. Indian Meteorites. C. A. Silberrad. *Min. Mag.* 23. *pp.* 290–304, *Dec.*, 1932.—The names of the places of fall or finding of 107 meteorites, of which 101 (3 irons) were seen to fall, in India and Ceylon have been revised, and the places as far as possible identified. The distribution in time is similar to that for the world, but the numbers recorded per given area per century vary greatly in different provinces. Assuming that

the average number is independent of place and time, and is at least equal to that where most day falls per given area have been recorded, *i.e.*, in the United Provinces, a thickly populated and cultivated area of some 100,000 sq. m., it appears that not more than 14 % of falls have been recorded. The very small number of found irons (1) is doubtless due to India having been for so long densely populated and cultivated. C. A. S.

See also Abstract, 917.

COSMOGONY.

916. Tidal Theory of Evolution of Solar System. L. N. G. Filon. *Roy. Astron. Soc., M.N.* 93. *pp.* 102–104, *Nov.*, 1932.—Jeffreys recently replied to an article by Nölke, and stated that the tidal theory, unlike his own, fails to account for the observed angular momentum of the planets [see Abstract 128 (1933)]. A well-known theorem of hydrodynamics is that the circulation $\int(udx + vdy + wdz)$ round any closed circuit consisting of the same particles of fluid remains constant for all time, and Jeffreys says that if this theorem is valid we should expect all the planets to have the same rate of rotation, equal to that of the sun before encountering the passing star. But there are limitations to this validity. The theorem ceases to hold if the fluid is viscous, or if its continuity is broken (as in a breaking wave). Moreover, the filament drawn out of the sun may have been formed of a large number of separate "drops," and one of these impinging obliquely upon another may have caused a considerable angulra momentum about their common centre of mass, thus violating the continuity condition. The circulation theorem therefore does not provide a convincing argument against the tidal theory. M. A. E.

DYNAMICAL PROBLEMS (ASTRONOMICAL).

917. Hyperbolic Orbits, Determination of True Anomaly and Time of Perihelion Passage. M. Davidson. *Roy. Astron. Soc., M.N.* 93. *pp.* 33–39, *Nov.*, 1932.—Special tables are needed to compute the quantities dealt with, for nearly-parabolic orbits; existing tables are not suitable for a computing machine. The area of the sector is written $= Sp^2/4e^2$ where $S = A - By + Cy^2 - Dy^3$ and A, B, C, D, are tabulated functions of $V = \tan(v/2)$. The tables extend from $V = 0$ to $5{\cdot}2$. They will suffice for $1 - e$ not greater than $\pm\ 0{\cdot}01$, which includes all known hyperbolic orbits. An example of use is given. T. L. M.

LATITUDE AND LONGITUDE.

918. Direct Method to Determine the Azimuth of a Signal. B. Berloty. *Bull. géodésique, No.* 32. *pp.* 303–310, *Oct., Nov., Dec.*, 1931.—A telescope, maintained motionless, is directed so that its vertical cross wire lies directly on the signal and the times are noted with the help of a chronograph when one or more stars pass the vertical cross wire. By this means repeated lengthy angular measurements are avoided and also errors due to displacement and levelling of the telescope. Vertical refraction is easily corrected but lateral refraction is more difficult. A general examination is made of the conditions which may influence the result, and these are applied to observations made at Kasara (Lebanon) when viewing a signal from Barouk. R. S. R.

NEBULÆ.

919. Radiative Equilibrium of Planetary Nebula. V. A. Ambarzumian. *Roy. Astron. Soc., M.N.* 93. *pp.* 50–61, *Nov.*, 1932.—The theory of radiative equilibrium of a planetary nebula consisting of hydrogen, is given, when the radiation in the nebula is not assumed to be "grey." This radiation consists chiefly of quanta of frequency greater than the limit of the Lyman series, together with the quanta corresponding to the first line of this series. The latter are due to absorption and subsequent re-emission in the nebula itself. The density of the radiation of this type is shown to be very much greater than that of the first kind, in the central parts of the nebula. The radiation pressure in the outer parts of the nebula is the dominant factor in the equilibrium and tends to overcome the gravitational attraction of the central star. G. C. McV.

920. Seventy-Six Thousand Faint Galaxies. H. Shapley. *Harvard Coll. Obs., Bull. No.* 889. *pp.* 1–3, *Nov.* 1, 1932.—At Harvard Kopje, Bloemfontein, under the direction of J. S. Paraskevopoulos, the Bruce 24-inch telescope is being used to photograph the whole southern sky up to 20° north, with fast plates of exposures 3 hours or more in length, and on each of these plates the number of nebulæ fainter than 14th magnitude is counted. In about six years the work should be complete. A diagram shows the fields already covered and the relative density of these faint extragalactic objects in each. They are scarce along the Milky Way, and irregularly distributed in higher galactic latitudes. In addition to objects already published, the diagram represents 76,000 new galaxies discovered in the present survey, and much more than half of these are fainter than 17th magnitude. Probably most of the 76,000 lie in the region between 30 million and 100 million light-years distant. M. A. E.

921. Hagen's Obscuring Clouds. K. F. Bottlinger. *Zeits. f. Astrophysik*, 5. *pp.* 359–366, *Dec.* 9, 1932.—Hagen and Becker's estimates of sky brightness, which led them to postulate the existence of numerous dark (or rather grey) obscurities, especially in high galactic latitudes, were made without using any artificial comparison source of light. No doubt many of the obscurities are real, but their impression that the sky background becomes increasingly lighter with increasing distance from the Milky Way was due to an effect of contrast. Quite a different method must be adopted, similar in principle to that of Yntema and van Rhijn, and of Hoffmeister, who compared the surface brightness of the sky with a disc illuminated by a faint blue light, which could be increased or diminished until the brightness equalled that of the sky. As in their careful and accurate work, measures should also be made of the aurora and the zodiacal light at certain latitudes, and of an unexplained but certainly existing Earth light in our atmosphere. M. A. E.

See also Abstract 941.

PLANETS.

922. Surface Brightness of an Illuminated Sphere. E. Schoenberg. *Zeits. f. Astrophysik*, 5. *pp.* 367–373, *Dec.* 9, 1932.—The conclusion drawn by Wirtz [see Abstract 4858 (1932)] that photometric measurements alone give no clue to the nature of the surface of a planet, is criticised on the ground that the laboratory experiments on which it is based are affected by very great errors when translated into astronomical terms. G. C. McV.

923. Photometric Study of Partial Lunar Eclipse of 14th Sept., 1932. F. Link. *Comptes Rendus*, 195. *pp.* 1236–1238, *Dec.* 19, 1932.—Observations of the optical density of the shadow on the region Aristarchus, made on the Pic du Midi at 2860*m* altitude in favourable atmospheric conditions, with a photometer such as used by Fabry and Buisson, and with two Wratten filters (mean wave-length for blue, $0{\cdot}46\mu$ and for red, $0{\cdot}62\mu$. A table of the comparisons made during the increasing and decreasing phases of the shadow give for the zenith an optical density of 0·125 (blue) and 0·034 (red). The outer parts of the shadow indicate a greater transparency during the decreasing phase than during the increasing, the reverse holding for the inner parts. As this eclipse was near the equinox, the terrestrial axis lay nearly along the apparent contour plane of the earth as seen from the moon, so that the northern temperate and tropical regions were seen in the increasing phase and the arctic regions in decreasing ; the effect indicated in the table is evidence that the absorbing layer in the upper atmosphere is higher at the equator than at the poles. This has been so found by Lugeon both for the ozone and the Heaviside layers ; for the latter he found a difference of 58 km. A. S. D. M.

STARS.

924. Reliability of Hypothetical Parallaxes. W. S. Finsen. *Roy. Astron. Soc., M.N.* 93. *pp.* 24–27, *Nov.*, 1932.—The paper forms a reply to D. Barbier [see Abstract 1171 (1932)] who regarded Russell's parallaxes as systematically erroneous since two of the quantities involved are correlated. It is shown that the constant used may be found on two assumptions : (1) stars of same hypothetical parallax being selected, the mean of their true parallaxes should equal their hypothetical parallax ; this involves Barbier's difficulty ; (2) stars of same true parallax being selected, the mean of their hypothetical parallaxes should equal their true parallax ; this only involves the assumption that a quantity dependent on the orbital elements is not correlated with the parallax ; the difficulty does not arise. (2) occurs when a criterion of selection implies selection by true parallax. Russell's parallaxes conform to (2) ; and Barbier's test by which he criticised Russell's parallaxes is shown to amount to comparing according to (1) a system satisfying (2). Cecchini's comparison of hypothetical parallaxes with trigonometrical, based on a grouping by value of hypothetical parallax, is shown to amount to the same operation. T. L. M.

925. Comparison of Potsdam, Bonn, and Cordoba Photometry with Harvard Photovisual Photometry. Cecilia H. Payne. *Harvard Coll. Obs., Ann.* 89. 3. *pp.* 63–77, 1932.—The Potsdam Photometry is shown to be identical with the Harvard Photovisual system (HPvP) in colour coefficient ; there is no traceable scale difference ; the zero-point differs by 0·28 magnitude. But the difference varies systematically in R.A. ; this is shown to be due to the method of correcting two early Harvard catalogues to the zenith, and corrections are tabulated ; the difference is not found in the Harvard Standard Regions. Bailey's southern catalogue (Harvard Ann. 46) shows a similar term ; this is tabulated, but no source is traced. Scale and colour corrections to reduce the Bonn Durchmusterung to HPvP are also given ; these are additional to corrections to Harvard Visual system already given by Pickering ; they are of the order anticipated from the difference of the two Harvard systems. Similar corrections are tabulated for the Cordoba Durchmus-

terung. The paper completes the inter-comparison of the various Harvard catalogues already given and enables all important catalogues to be reduced to HPvP. T. L. M.

926. Limiting Magnitude Observable with a Photoelectric Stellar Photometer. S. Smith. *Mt. Wilson Observat. Contrib. No.* 457. *Astrophys. J.* 76. *pp.* 286–290. *Dec.*, 1932.—Random fluctuations in the number of photoelectrons produced per second are shown to set an assignable lower limit to the useful sensitivity of a photoelectric cell. The case of a potassium hydride cell attached to the 60-inch reflector is treated numerically, and the minimum time intervals during which photoelectrons must be collected in order to make 1 % measurements on the light from a star of a given magnitude are tabulated. AUTHOR.

927. Stellar Residual Radial Velocities: Velocity Ellipsoids and Temperature Gradient of the Galaxy. H. Mineur and Mme. H. Mineur. *Bull. Astronomique*, 7. 8. *pp.* 321–352, 1932.—The classical analysis previously given [see Abstract 61 (1932)] would be precise if the mean radial velocity of stars in any direction were that defined by the direction cosines α, β, γ, and the components of the solar motion. Corrections may be due to constant K-term; to a variation in the solar motion with reference to star-group studied; to differential galactic rotation (second degree terms in the direction cosines). The necessary expansion is carried out and the terms in the equation for θ are written as far as coefficients of Y_5. As a special case the correction to the vertex, assumed in the galactic plane, required to take in the Oort terms, is found to be very small, $\Delta l = +0°.3$. Velocity ellipsoids are found for seven classes of stars: for A, F, GKM dwarfs, and near GKM giants, longitude of vertex is near 345°; for distant GKM giants, 325° (nearer centre of galaxy); but for B stars, near and distant, 293° and 299°; in the last case the figure is slightly ellipsoidal only. In all cases the corrections introduced are under half the probable error. Defining as previously [see Abstract 4201 (1932)] the temperature of the galaxy as proportional to the mass of the stars in unit volume and to the square of their mean velocity, the former is assumed constant, and the latter computed; but the results are of the same order as their mean square error. If significant they imply an increasing temperature with departure from the centre. Considering the residual velocity as a function of the longitude the nearer stars give an approximately symmetrical curve according with the ellipsoidal hypothesis; distant stars a curve with three maxima (so Strömberg) which is difficult to interpret. T. L. M.

928. Galactic Rotation Effect in Late-Type Stars. R. O. Redman. *Dominion Astrophys. Obs., Victoria, Publ.* 6. 5. [48 *pp.*], 1932.—A list of the radial velocities of 224 seventh magnitude K stars is given, in continuation of a previous list [see Abstract 2622 (1931)]. Least squares solutions for the solar motion give a velocity for the sun of $20{\cdot}5 \pm 1{\cdot}3$ km/sec. towards an apex whose equatorial co-ordinates are $\alpha = 280°$, $\delta = +30°$, which is thus rather to the north and east of the apex for the naked-eye stars. No second harmonic term in satisfactory agreement with galactic rotation theory is, however, found. A short account of the present position of galactic rotation theory is given. G. C. McV.

929. Proper Motions of Stars in Region of M31. Violet F. White. *Roy. Astron. Soc., M.N.* 93. *pp.* 105–109, *Nov.*, 1932.—Proper motions are

deduced for all stars outside the nebula and within 27′ of the field centre on two plates taken at dates differing by 35 years. The plate constants are determined in three ways ; Christie and Dyson's method gives as accurate results as least squares. The magnitudes of the stars are estimated and divide into two groups of 10th and 12th magnitudes respectively. A table gives the mean relative proper motions and mean parallels of the separate groups, and from these the absolute proper motions of the numbers of the stars, r, moving in the direction of P.A., θ, are tabulated and shown graphically. There is also given a table of the number of stars in the region with proper motions, $\mu(\equiv \sqrt{\mu_x^2 + \mu_y^2})$ between various limits [see Abstract 3197 (1932)]. A. S. D. M.

930. Spectrophotometric Temperatures of 353 Stars. Georgette Maulbetsch. *Harvard Coll. Obs., Circ. No.* 377. [6 *pp.*], *May* 28, 1932.—Results previously obtained [see Abstract 4136 (1931)] indicated that further research might yield important data for absolute stellar magnitudes. Present results in different regions near the same field confirm the general increase in absolute value of spectrophotometric gradients down the spectral sequence, and also the distinction in gradient values between dwarfs and giants in late spectral classes. It is also found that a general relation exists between the gradients and the absolute magnitudes determined by Lindblad, so that it will now be possible to derive a criterion for absolute magnitudes from gradients and spectral classes. M. A. E.

931. Absorption Lines of Hydrogen in Be Stars. O. Struve. *Astrophys. J.* 76. *pp.* 309–312, *Dec.*, 1932.—Contours of the absorption borders on the edges of the bright hydrogen lines $H\beta$ and $H\gamma$ in 14 Be stars are given. Comparison with the contours of the same lines in ordinary dark-line B stars of the same spectral subdivisions shows that they are practically identical. A very slight systematic widening of the absorption borders in the Be stars may be due either to axial rotation or to individual differences between separate stars. The similarity of the contours for stars of classes Be and B is in agreement with the hypothesis that bright lines originate above the reversing layers of the stars, and that on the spectrograms they are superposed over normal absorption lines. Author.

932. Period of 12 α^2 Canum Venaticorum. Goldena Farnsworth. *Astrophys. J.* 76. *pp.* 313–314, *Dec.*, 1932.—From a study made of series of spectrograms taken at several observatories during the years 1913–1932, the period of 12 α^2 Canum Venaticorum, 5·46939 days, was found to be constant within the errors of measurement. Author.

933. Four A- and F-Type Stars whose Spectra Contain Variable Absorption Lines. W. W. Morgan. *Astrophys. J.* 76. *pp.* 315–316, *Dec.*, 1932.—The stars 49 Cancri, ω Ophiuchi, 73 Draconis, and γ Equulei contain variable absorption lines in their spectra. Author.

934. Spectrum of the A2 Dwarf ϵ Serpentis. W. W. Morgan and Goldena Farnsworth. *Astrophys. J.* 76. *pp.* 299–308, *Dec.*, 1932.—Wave-lengths and identifications are given for 244 lines in the spectrum of ϵ Serpentis between the limits $\lambda\lambda$ 3997–4629. The elements definitely found to be present are : H, Mg I, Mg II, (Al I), Si II, Ca I, (Ca II), Ti II, V II, Cr I, Cr II, Mn I, Fe I, Fe II, Ni I, Ni II, Sr II, Y II, Zr II, Ba II, and La II. The lines of Al I and Ca II lie outside of the observed range. In addition to the elements listed, Sc II and Co I may be present. Authors.

935. Boundary Temperature of a Star. E. A. Milne. *Zeits. f. Astrophysik*, 5. *pp.* 328–336, *Dec.* 9, 1932. *In English.*—The usual differen-

tial equation of radiative equilibrium is shown to hold up to the boundary of a star as an expression of radiative equilibrium provided that the Schwarzschild boundary temperature is used. The effect of different boundary conditions on the theory of stellar equilibrium is discussed in some detail. G. C. McV.

936. Numerical Integration of Emden's Equation Index 3. N. Fairclough. *Roy. Astron. Soc., M.N.* 93. *pp.* 40–49, *Nov.*, 1932.—Tables of two further solutions of the equation, which possess singularities at the zero of the independent variable, are given. A series of tables giving the values of certain functions associated with these and other solutions are also given, use being made of the tables already published [see Abstract 3685 (1932)]. G. C. McV.

937. Applications of Degenerate Statistics to Stellar Matter. D. S. Kothari. *Roy. Astron. Soc., M.N.* 93. *pp.* 61–90, *Nov.*, 1932.—The formulæ for transport phenomena such as thermal and electrical conduction, diffusion, viscosity, etc., of degenerate and non-degenerate matter already arrived at [see Abstract 2904 (1932)] are applied to the discussion of the stellar problem. It is shown that the flow of energy in degenerate matter in a stellar interior is largely by conduction and not essentially a radiative transfer. Thus the effective opacity should be taken proportional to T^2/ρ^2 instead of to $1/T^2$, as is usually assumed. Gas pressure predominates over radiation pressure in degenerate matter and gas viscosity is large compared with that computed for a classical gas at the same density and temperature. The application of these results to a model white dwarf of luminosity $L = 10^{31}$ ergs/sec. and mass $M = 10^{33}$gm., built on the two-phase generalised model, yields the result that the central temperature is of the order of 10^7°C. G. C. McV.

938. Theory of Stellar Structure. Part II. Energy Generation. E. A. Milne. *Zeits. f. Astrophysik*, 5. *pp.* 337–347, *Dec.* 9, 1932. *In English.*—Rosseland's analysis of stellar equilibrium with an energy generation law $\epsilon = \epsilon_0 T^s \rho^t$ is treated by means of a set of four differential equations freed from physical constants. It is shown that two types of problem arise, according as ϵ_0 is considered known or unknown. The first yields luminosity and radius laws of the type $L = \phi(M)$ and $r_1 = \phi(M)$, and a theoretical "Russell diagram relation" $Te = \phi(L)$. The second case yields a thermodynamic relation of the type $r_1 = \phi(L_1, M)$ not involving ϵ_0. The linear dimensions of a configuration of given L and M are in principle calculable without a knowledge of ϵ_0, provided s and t are known, and the dimensionless variables occurring are the same as when ϵ = constant. It suggested that the law of energy generation may be of the type $\epsilon = F(dT/dt)$. G. C. McV.

939. State of Matter in the Interior of Stars. S. Chandrasekhar. *Zeits. f. Astrophysik*, 5. *pp.* 321–327, *Dec.* 9, 1932. *In English.*—By considering the conditions of continuity of the perfect gas envelope and degenerate gas core at the interface, it is shown that for all centrally condensed stars (on the standard model) whose mass is greater than $1{\cdot}656\ \odot$ the perfect gas equation of state does not break down, however high the density may become, and the matter does not become degenerate. An appeal to the Fermi-Dirac statistics to avoid the central singularity cannot be made. It is shown that all centrally condensed stars must have a homogeneous core at the centre with a discontinuity of density at the

interface. These results are independent of assumed differences in the opacities of perfect and degenerate gases. G. C. McV.

940. Rotation of the Milky Way. K. F. Bottlinger. *Ergeb. d. exakt. Naturwiss.* 11. *pp.* 31–63, 1932.—Consists of a critical survey and discussion of the outstanding researches on this subject grouped under the following sub-titles :—Stellar-statistics methods, stellar motions in the neighbourhood of the sun, differential rotation, theoretical motions in the neighbourhood of the sun, spatial extension of the system, comparison of theory with observation, star clusters and Magellanic clouds. J. E. K.

941. Distribution of Absorbing Galactic Matter. H. Mineur and A. Machiels. *Comptes Rendus*, 195. *pp.* 1234–1236, *Dec.* 19, 1932.—The author utilises the catalogues of Shapley (I) down to photographic magnitude 13, and Fath-Seares (II) down to 18·6. High galactic latitudes are excluded. They assume that the absorbing matter lies between two parallels (distance $2h$) to the galactic plane, and that the sun is distant z from that plane. They use the formulæ $y'(m,b) = y(m) \pm Kh(dy_m/dm)$ cosec b {— for south and + for north}, and $y'(m,b) - y') (m - b) = 2\ Kz(dy_m/dm)$ cosec b, where $N(m)$ is the number of nebulæ per square degree with no absorption, and $N'(m,b)$ is the number of stars effectively observed at latitude b, and the coefficient of absorption, $K = 0{\cdot}7(10)^{-3}$ mag. parsec^{-1}. They find for (I) : $z = +95$ parsecs ± 12 ; (II) : $z = +119$ parsecs ∓ 30. So that the sun is situated about 100 parsecs north of the galactic plane. For h (I) gives 1500 parsecs and (II) gives 1200 ; both impossible values, indicating that the absorbing matter is not distributed uniformly between two planes, even as a first approximation. A. S. D. M.

942. Mean Light-Curves of Long-Period Variable Stars. Part IX. χ Cygni. A. A. Nijland. *K. Akad. Amsterdam, Proc.* 35. 8. *pp.* 1030–1038, 1932. *In German.*—It is deduced from 962 observations made in the years 1905 to 1932 that χ Cygni has a maximum of $4^m{\cdot}48$ and a minimum of $13^m{\cdot}35$ with a period of 407 days. The star appears to undergo, on the rise towards the maximum, a darkening of $2^m{\cdot}91$ which has a perfectly symmetrical character. J. E. K.

943. Light-Curves of Long-Period Variable Stars : Part X. T. Ursae Majoris. A. A. Nijland. *K. Akad. Amsterdam, Proc.* 35. 9. *pp.* 1126–1131, 1932.—764 observations, 1905–32, give elements : minimum, 2,421,928 + 255·6 E + 9 sin 5° (E − 8), in days ; maximum 105 days after minimum ; amplitude $7^m{\cdot}58 - 13^m{\cdot}53$. The added term reduces residuals greatly, but seems unsuitable for older observations. The mean light curve is quite smooth, resembling R Trianguli. 93 colour observations show variations with magnitude and apparent deepening about 1911, the reality of which is doubted by the author. T. L. M.

944. Variation of Eccentricity and Semi-Axis Major of a Spectroscopic Binary. M. H. H. Walters. *Roy. Astron. Soc., M.N.* 93. *pp.* 28–33, *Nov.*, 1932.—The author extends the methods of his first paper [see Abstract 4179 (1932)] to eccentricities less than before for the hyperbolic orbit of a disturbing star ; he also considers closer approaches. More definite evidence of increase of eccentricity is obtained ; but the semi-axis major increases only slightly. A difficulty regarding the time-scale, which is too long for current views (10^{13} years), is discussed ; the time-scale

may be reduced if the stars were initially closer. A correction to the previous paper is given. T. L. M.

945. Colours of SS Cygni Variables. B. P. Gerasimovič and Cecilia H. Payne. *Harvard Coll. Obs., Bull. No.* 889. *pp.* 3–6, *Nov.* 1, 1932.—It is found that the mean colour index for flat maxima of SS Cygni is $+ 0^m \cdot 1$, and for sharp maxima $- 0^m \cdot 1$, while at miminum the mean is $+ 0^m \cdot 3$, so that the average difference in colour between maximum and minimum is 3/10ths of a magnitude. U Geminorum, a variable of the same class, also shows a difference of the same value between maximum and minimum. Thus the large increase in light from minimum to maximum is not accompanied by a large change in colour, which would occur if the cause were purely thermal. It is very unlikely that the temperature is actually very high at maximum but the colour reddened by local or cosmic absorption, for the spectra are incompatible with this state. Nor is it possible that the observations are affected by errors in the zero point and scale of magnitudes, in view of the care taken in checking the comparison stars. Change of temperature, therefore, plays only a secondary part in producing changes of brightness in SS Cygni stars, and the most probable cause is a change in effective radius, a type of Nova-like expansion unaccompanied by large changes in temperature, as in the early stages of Nova Pictoris. M. A. E.

See also Abstract 919.

SUN.

946. Total Solar Eclipse of Aug. 31, 1932. Reports of the British Expeditions. C. R. Davidson, J. Jackson, F. J. M. Stratton and R. L. Waterfield. *Roy. Astron. Soc., M.N.* 93. *pp.* 3–21, *Nov.*, 1932.—Davidson and Jackson, who were joined by Slouka of Prague and Witchell of Greenwich Observatory, went to Parent, 252 miles N.W. of Quebec. In spite of clouds, the grating slit spectrograph and the prism slit spectrograph both showed a few lines, the 45 ft. coronagraph gave photographs of prominences and a little of the inner corona, and the Simms coronagraph showed enough of the outer corona to prove its typical minimum form. With the objective prism quite good results were secured : the coronium line at λ 6374 appears as a nearly complete ring of practically uniform intensity, but the coronium line at λ 5303 is quite different, appearing generally on the west side of the sun, but missing on the east, and specially strong near position angle 280°, where the corona is strong on the direct photographs, above a low-lying prominence. Three limb photographs and three spectra are reproduced. The great need in future eclipses is to obtain accurate photographic intensities of lines, especially of multiplets, a comparison spectrum being secured with the same instrument. Stratton, with Carrol, Redman and Butler, went from the Solar Physics Observatory, Cambridge, to Magog in South Quebec. W. Hall joined them with his own instruments. The programme included spectrophotometric, spectroscopic, and interferometric measures, photographs of the corona, studies of polarisation and rotation of the corona, and observations of changes in air temperature and humidity. Owing to heavy cloud, only the last could be carried out, and diagrams of the changes are given. It appears that during a cloudy eclipse the fall in temperature is very slight. Waterfield, with Peek, Phillips, and some American observers, went to Gorham in New Hampshire equipped with three coronagraphs and two spectrographs, but obtained no results owing

to cloud. Four members of the party observed totality in a clear sky by driving for about thirty miles in a fast car. M. A. E.

947. Theory of Sunspot Formation. M. Minnaert and A. J. M. Wanders. *Zeits. f. Astrophysik*, 5. *pp.* 297–320, *Dec.* 9, 1932.—The theory of Russell, that sunspots are produced by adiabatically expanding, rising, and cooling gases, is tested against observation of the variation of the ratio of the intensity of a spot to that of the photosphere, (1) with wave-length; (2) with distance from the centre of the disc. The observational evidence is discussed. The radiation emitted by the spot is computed on the theory, attention being paid to the effect of transparency of the gases. In case (1) the ratio specified is found to increase with the wave-length much more slowly than is observed; in (2) theory indicates a rapid fall of the ratio towards the limb which is not supported by observation. Therefore refinements of the adiabatic theory are considered. (1) Correction for visibility through the gases of the spot of deeper photospheric layers; (2) variability of absorption coefficient; (3) effect of the Hydrogen ionisation on the temperature of the rising gases; (4) effect of radiation pressure on the convective equilibrium. In all cases the result is either negligible or productive of greater discrepancies between theory and observation. But if the assumption of convective equilibrium is replaced by that of pure radiation equilibrium, a close agreement with the available observational data is obtained. This assumption leads to an effective temperature of sunspots of around 4300°. Farther, the last hypothesis removes the difficulty that no trace has been found of rising currents in the umbra of sunspots. T. L. M.

948. Statistical Study of Solar Faculæ. H. Strebel and B. Thüring. *Zeits. f. Astrophysik*, 5. *pp.* 348–358, *Dec.* 9, 1932.—A photometrical method, using ultra-violet photographs of the sun, is developed for giving an exact definition of the extent and brightness of a facula. The object is to obtain the relative area of the sun's surface occupied by these features. It is found to be 62 % of the surface and the amount of light emitted by the faculæ is found to be about the same proportion of the total luminosity. G. C. McV.

949. Wave-Lengths of H and K lines of Calcium in Arc in Vacuo and their Red Shifts in Solar Spectrum. C. V. Jackson. *Roy. Astron. Soc., M.N.* 93. *pp.* 98–102, *Nov.*, 1932.—These lines have been measured by three different observers in air, and some measures have been made by interferometer in vacuo, when the lines were present as impurities, but on account of their great importance in astrophysical problems it seemed desirable to make a special investigation by the interferometric method. A brief account of the previous measurements, and details of the present research are given. The lines were compared with the new I.A.U. krypton standards, and found to be $3968{\cdot}470 \pm 0{\cdot}0006$Å and $3933{\cdot}664 \pm 0{\cdot}0006$Å, which is in good agreement with the mean of the results of earlier observers. The mean red shifts of the H and K lines in the solar spectrum are found to be 0·021 Å and 0·014 Å for the centre of the disc and for prominences respectively, and this is within 0·001 Å of the values found by Evershed by direct comparison of arc and solar lines. M. A. E.

950. Photometry of Solar Spectrum Lines. C. D. Shane. *Lick Observat., Bull. No.* 449. *pp.* 76–89, *Nov.* 16, 1932.—Any adequate interpretation of astronomical spectra must be based largely on accurate wave-

lengths and line intensities. The present investigation develops the determination of an absorption line profile freed (largely) from systematic errors. These profiles have been made both in the ordinary way and from spectrograms crossed by interference fringes. The correction of observations by the use of an integral equation of the first kind is developed ; it may be solved indirectly and the corrected profiles derived ; application to solar lines, with plates and graphs, is given. The kernel of the integral equation represents the distribution of monochromatic light on the spectrogram. Since the kernel appropriate to the interferometer spectrograms is more strongly concentrated near its maximum value than in the ordinary kernel, this observational procedure has the greater inherent accuracy. The following are generalised results : the profiles are rather strongly curved at their minimum ; wings begin to appear in lines of Rowland intensity 5 or 6 ; the maximum shape on each line is practically constant over a considerable distance ; lines of intensity 1 to 4 inclusive have approximately the same maximum slope (7 % per 0·01Å) ; for stronger lines the slope decreases with increasing intensity. There are a number of improvements indicated in observational technique. A. S. D. M.

951. Measurement and Interpretation of Fraunhofer Lines. S. A. Korff. *Mt. Wilson Observat. Contrib. No.* 459. *Astrophys. J.* 76. *pp.* 291–298, *Dec.*, 1932.—The Fraunhofer D lines of sodium and E_b lines of magnesium were photographed with the 75-foot spectrograph and their contours measured with a microphotometer. These lines were found to have wings agreeing with the radiation damping theory, provided the theoretical contour is fitted at the point where about 0·80 of the light of the continuous background is transmitted—a value higher than that used by most observers. The observed contours show that about 0·25 of the background intensity is transmitted at the centres of the lines. The application of recent experimental data on interaction widening is discussed. It is found that the contribution of interaction to the total width of the lines is small. Quantitative analysis of the solar atmosphere based on the widths of lines produced by scattering is found possible provided the widths are measured in the wings of the lines. Author.

952. Relations of Stellar Electricity and Magnetism to Phenomena of Sun's Atmosphere. R. Gunn. *Science*, 76. *pp.* 577—583, *Dec.* 23, 1932. *Paper read before the Am. Assoc. for the Advancement of Science.*—The author summarises the evidence for his view that the sun's magnetic field is distorted by diamagnetism in the sun's atmosphere. The anomalies of solar rotation are discussed. The magnetic axis being 6° inclined to the axis of spin, a semi-rigid interior is assumed, with reference to which the atmosphere is in systematic motion maintained by the sun's electric field. This is presumed on analogy to be radially inward and therefore over most of the surface sensibly perpendicular to the magnetic field. The atmospheric ions are subject to forces exceeding those of gravity and radiation pressure ; the sun's stability therefore depends primarily on electromagnetic forces. This is used to account for the observed difference between the sun's effective temperature and its radiation quality temperature, especially the failure of the Saha theory to predict the abundance of certain ions ; there is serious departure from thermodynamic equilibrium except for neutral atoms and electrons. T. L. M.

See also Abstracts 909, 969, 1153.

GEOPHYSICS.

GEODESY.

953. Boundary Value Problem of Geodesy and the Determination of Geoid Oscillations from Gravity Measurements. K. Jung. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 233–251, 1932.—The task of computing the shape of an equipotential surface from gravity values in points of this surface is called the boundary problem of geodesy. The author shows that this problem has a unique solution if all masses are situated inside the equipotential surface, but it has an infinite number of solutions if there are masses inside and outside the equipotential surface. Consequently other methods which have been suggested, such as Höpfner's, which give a unique solution in the latter case, are incorrect and computations of the geoid based on gravity values reduced by Prey's method cannot be used. The determination of geoid oscillations from gravity measurements is then developed by means of spherical functions, and formulæ are given which provide a solution of the problem of boundary value.
R. S. R.

954. Formulæ of Vening Meinesz and Callandreau and Other Formulæ of Higher Geodesy. N. Malkin. *Gerlands Beitr. z. Geophys.* 38. 1. *pp.* 53–63, 1933.—The formula derived in a rather complicated way by Vening Meinesz can be stated if one allows the pole of the spherical co-ordinates to coincide with the earth's pole. Similarly one can obtain the expression for the second tangential derivative of the potential. Further, the inverse formula can be derived which gives the force of gravity from the deflection of the plumb line. Similarly the expressions for the radial gradient of the force of gravity, and consequently the mean radius of curvature of the geoid are derived from the given values for the force of gravity. Finally Callandreau's formula for the determination of the figure of the earth is replaced by a much simpler one depending upon deviations of the plumb line. It is shown that all the results obtained can be applied almost without change to the Gaussian theory of terrestial magnetism. [See Abstract 3184 (1928).] R. S. R.

GEOPHYSICS, APPLIED.

955. Principles and Practice of the Gradiometer. E. Lancaster-Jones. *Journ. Sci. Instruments.* 9. *pp.* 341–353, *Nov., and pp.* 373–380, *Dec.*, 1932.—A description is given of the conditions in practical prospecting calling for a more portable and rapidly acting gravity balance and leading up to the design of the gravity gradiometer. The dynamics of the suspended system of a gravity balance and the dynamical characteristics of the gradiometer are discussed. A detailed description of the original instrument follows, with particulars of latest improvements. Finally, a review of the field performance, as regards sensitivity and accuracy, of the gradiometer is given, with an account of a comparative test made on it in conjunction with a standard type of torsion balance. The gradiometer is shown to be

a great improvement in the direction of portability and rapidity of action and the design entails very little sacrifice of sensitivity, The latest pattern can be made five times as sensitive as the earlier model, without diminution of the rapidity of action. AUTHOR.

HYDROSPHERE, PHYSICS OF THE.

956. Submarine Phenomena in the Bay of Villefranche-sur-Mer. Idrac. *Comptes Rendus*, 195. *pp.* 1410–1413, *Dec.* 27, 1932.—The temperature of the sea at various depths up to 30 m. in the bay of Villefranche-sur-Mer, when plotted against time, shows periodical variations of varying periods of the order of several hours, sometimes in harmony with the tides, and also smaller oscillations of period 3–10 minutes of unknown origin. These variations in temperature would explain the slow submarine currents observed. C. A. S.

See also Abstract 889.

LAND, PHYSICS OF THE.

957. Flow of Heat from a Rock Stratum in which Heat is being Generated. C. E. van Orstrand. *Washington Acad. Sci., J.* 22. *pp.* 530–547, *Dec.* 19, 1932.—Depth-temperature curves have been calculated on the assumption that a source of heat is introduced at a given time along a horizontal stratum of indefinite extent and negligible thickness at various depths, and acts for various periods. Results indicate that where the heat generating stratum has been in action for a long time the only evidence of its action would be the greater steepness of the heat gradient as compared with the gradient in a neighbouring position where no such heat source was acting. C. A. S.

958. Thermomagnetic Properties of Volcanic Rocks. R. Chevallier and J. Pierre. *Ann. de Physique*, 18. *pp.* 383–477, *Dec.*, 1932.—Magnetic moment temperature (M/T) curves have been determined for numerous samples of lavas between 0° and 620° C., and the Curie points deduced [see Abstract 3433 (1932).] The different forms of these curves and their changes on cooling and reheating are discussed in detail with the conclusion that the magnetic material is a solid solution of Fe_2O_3, FeO, and TiO_2 in varying proportions. The thermomagnetic properties actually depend on the proportion of Fe_2O_3 present. The Curie point coincides with that for magnetite when this is $\lessapprox$ 70 % (by weight), and decreases linearly to 0° C. when it is 10 % [see Abstract 2899 (1930).] It is doubtful whether the ratio TiO_2 : FeO has any influence, the governing ratio being apparently more generally $s = Fe_2O_3/(Fe_2O_3 + FeO + MgO + CaO)$, Fe_2O_3, etc., indicating numbers of molecules, and CaO the amount of lime not contained in a plagioclase. Variations in the M/T curves for samples from various parts of a lava flow are consistent with the probable variation in amount of Fe_2O_3 caused by oxidation. C. A. S.

METEOROLOGY.

959. Brief Review of the Physics of the Upper Atmosphere. J. Bartels. *Zeits. f. techn. Physik*, 13. 12. *pp.* 611–616, 1932.—The author reviews published facts relating to the upper atmosphere and conclusions which have been drawn from observations of clouds at high levels, twilight phenomena after volcanic outbursts, travel of meteors,

light of the night sky, absorption of ozone and its variations, propagation of sound waves to large distances, production of auroræ, propagation of electromagnetic waves and variations of terrestial magnetism. He examines the theories put forward to account for the ionisation layers at 100 and 220 kms. Variations of terrestial magnetism, of short and long periods are discussed in their possible relation to dynamo action in the upper atmosphere and changes produced by solar disturbances. R. S. R.

960. Air Masses in the Troposphere. M. Bossolasco. *Com. Naz. Italiano Geod. e Geophys., Boll. No.* 7. *pp.* 113–125, *July*, 1932.—After reviewing the methods available for tracing the course of air masses in the troposphere, and emphasising the relative value of aerological soundings distinct from surface observations, the author stresses the importance of regular and frequent observations at the few aerological stations which exist, and the desirability of representing those characteristics of air masses which persist for long periods and therefore serve to identify the particular mass during its motion. Among the diagrammatic modes of representing aerological data at a station, the author singles out the tephigram of Napier Shaw and the tetagram. The latter is a record of the temperature—equipotential pressure, or temperature-altitude correlation, and has the advantage of simplicity for the purposes of comparison with similar records at other stations, although it does not represent all the elements observed by sounding balloons. Experience at Breslau Observatory has established a definite correspondence between the homologous curves of the tetagram and typical moving air masses. Instances of the use of this diagram in Italy are quoted and analysed in particular for two soundings taken at Vigna di Valle in the February and August of 1929. The conclusion is drawn that in central Italy the presence of active tropospheric air masses with disturbing strata on the ground is as frequent in summer as in winter, indicating a divergence from the conditions in central Europe. Also, the homologous curves show for Italy a less curvature than those encountered in countries at higher latitudes. And, finally, the characteristic values of the equipotential temperature for such air masses as are typical in Italy differ appreciably from those resulting from soundings carried out in more northerly regions. E. L. J.

961. Some Characteristics of the Tropopause and Upper Troposphere over N.W. India. N. K. Sur and J. C. Roy. *Indian Meteorolog. Dept., Sci. Notes*, 5. 48. *pp.* 19–31, 1932.—From sounding balloon ascents at Agra during the period April, 1926, to December, 1930, the mean height (H_c) and temperature (T_c) of the tropopause with the standard deviation of each was found for the three principal types of tropopause over N.W. India and the monthly percentage frequency of each tabulated. No relation with mean sea level pressure is found for H_c and T_c during the summer and rainy seasons, but in winter the relation is similar to that found by Gold, the upper atmosphere being controlled by pressure gradients of temperate latitudes. No appreciable seasonal variation of height of the tropopause was noticed. Mention is made of the characteristic region of small lapse or inversion commonly found at 11·5–14 geodynamic km. Rossby's theory of advection of air masses with the assumptions and the main results are set out. This theory is applicable only to a limited class of advection phenomena and observations of the pressure, temperature and humidity obtained from soundings over 7 days at Agra in a winter anticyclone over Upper India can be accounted

for in this way. Support is given to the views of Dines and Douglas [see Abstract 3279 (1929)]. These results show that an upper anticyclone was brought into existence by the advection of tropical air into northerly latitudes above the tropopause, and the anticyclone thus formed then extended into lower levels. R. S. R.

962. Inversions of Lapse-Rate of Temperature over Karachi. A. S. Hariharan. *Indian Meteorolog. Dept., Sci. Notes*, 5. 48. *pp.* 41–48, 1932.—Eye observations during 230 aeroplane ascents over the period June, 1927, to June, 1930, were used to determine the mean monthly frequency of inversions, the temperature and height of the base, thickness of the layer and the temperature difference and lapse rate through it. Examination of the air tracks shows that for the hot season and monsoon the air is derived from Iraq and the inversion results from cooling by, and evaporation from, the sea surface passed over before reaching Karachi, turbulence causing the ascent of the cooled air. In winter inversions (except those close to the surface) are feeble, rare, non-permanent, of variable height, and mostly frontal with dry air below and moist air above, while they are associated with western depressions. Two individual cases are examined and described in more detail. R. S. R.

963. Daily Barometric Pressure and Temperature Variation in the Free Atmosphere and in Mountain Valleys. A. Wagner. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 315–344, 1932.—The daily barometric variation Δb at different altitudes in the Alps from May to August is almost solely dependent on altitude and independent of locality. The daily temperature variation ΔT, deduced by the formula $\Delta T/T = \Delta b/b + (RT/b)\, d\,(\Delta b)/dh$, shows a regular diminution in amplitude and retardation of phase with height h. Thus determined the mean daily variation of temperature between the bottom of a mountain valley and the crest of the enclosing ridge is more than double the variation for the same difference in height over a plains area as determined by kite or balloon. Such differences in rate of variation over plains and valleys give rise to differences in pressure which produce the characteristic mountain valley winds. C. A. S.

964. Variations of Annual Means of Atmospheric Pressure by H. Arctowski and J. Teśla. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 131–145, 1932. *In French.*—This paper deals with a continuation of earlier work on pleionian variations of temperature for the period 1910-1919 by the same authors. Different types of curves of 12 monthly means of atmospheric pressure for the same period are discussed. The stations considered are scattered over the globe and number 106 in all. In the temperature investigation the curve for Arequipa was taken as the type for comparisons. A comparison of this curve with the pressure and temperature curves for Batavia shows that these strongly resemble one another. The pressure curve for Batavia has been taken in consequence as the type for comparison. Various modifications of this type of curve are found. Some, such as at Apia, are the reverse of the Batavia curve. Another modification is exhibited at Helwan where the maxima of 1911 and 1914 exhibited by the Batavia curve become fused into one. An interesting map of iso-amplitudes of variations is given indicating a maximum in E. Asia, a progressive increase from S. to N. on the Atlantic and an increase from N. to S. over Australia. The Batavia type

of curve is not the only type found. Another distinct type of variation occurs in Iceland, in the northern Pacific and also in New Zealand. The authors consider therefore that in the variations of atmospheric pressure the types that have been distinguished represent only modifications of the effect of the action of one and the same factor acting as a premier cause; and that it is this factor that produces the thermopleional variations. As it is found that the temperature variations follow closely rhythmic variations in certain solar phenomena, they conclude that if the changes in the distribution of excess or deficit of pressure be attributed to thermopleionian variations, and these, in turn, be due to certain rhythmic changes in solar phenomena, then it is necessary to pursue, very carefully and very gradually, the study of synoptic climatic anomalies. A. E. M. G.

965. Thermodynamics of the Atmosphere. A. Refsdal. *Geofysiske Publ.* 9. 12. [63 *pp.*], 1932. *In German.*—The author refers to a former paper [Abstract 3357 (1930)] in which the source of energy in showers and cyclones is shown to be mainly in the lability energy. This idea is further developed. In Pt. I a generalisation and further development is made of Margules' work on the energy of storms. For this purpose the theory of the pressure-volume diagram is explained and the different forms of energy in the atmosphere considered. Difficult energy transformations can be performed simply and exactly on these energy diagrams. In Pt. II the ideal thermodynamic machine is explained and general considerations are obtained for reversible water processes in the atmosphere. The diurnal double wave of pressure in the atmosphere is shown to be a necessary result of the daily variation of lability energy. In Pt. III these results are applied to obtain the main tracks for the atmospheric circulation in tropical and extra-tropical regions, and the production of the trade winds, land and sea breezes, mountain and valley winds, and monsoon winds. In Pt. IV the vertical circulation of the whole atmosphere, the variation in height of the tropopause, and the circulation between the troposphere and the stratosphere are considered. Constructions are obtained for the energy transformations during these movements for tropical cyclones, anti-cyclones and depressions. Finally the formation of mother-of-pearl clouds is traced to water vapour driven into the stratosphere by volcanic activity even to the ozone layer. By sinking and cooling condensation occurs on ions. The size of the drops, and the colour, shape and irisation of the clouds can be accounted for in this way. R. S. R.

966. Determination of Humidity by the Psychrometer. E. Genberg. *Gerlands Beitr. z. Geophys.* 37. 4. *pp.* 367–385, 1932.—Existing theories are criticised and the factor A is shown definitely to be not a constant. For it the formula $A = C_L(1 + \epsilon_1)\ (1 + \epsilon_2)\ (1 - \epsilon_3)/R\gamma$ is deduced, where C_L is the specific heat of air at constant pressure, R the latent heat of vaporisation of water at 0° C. and 760 mm., γ the specific gravity of water vapour (air = 1), and ϵ_1, ϵ_2, ϵ_3 are complicated correction numbers. ϵ_1 and ϵ_3 depend on the ratio of the saturation vapour pressure at the wet-bulb temperature to the barometric pressure. The formula is then reduced to $A = C_L(1 - \epsilon_o)\ (1 + \epsilon_2)/\gamma R$, and for temperatures −20°, 0°, 10°, 20° and 30°. ϵ_o is determined to be 0·001, 0·005, 0·010, 0·019 and 0·034 respectively; it is next further reduced to $A = A_o(1 + \epsilon_2)$, A_o varying between 0 and $6{\cdot}48 \times 10^{-4}$. ϵ_2 depends on the ratio of the quantity of heat taken up by the wet bulb to the quantity of water evaporated during the same time. A method for determining it is given and its

value is exemplified by determinations of 0·03 and 0·25 to 1·5 for an Assmann and an unventilated psychrometer respectively. C. A. S.

967. Psychrometer Constant: A Correction. M. Robitzsch. *Gerlands Beitr. z. Geophys.* **37.** 4. *pp.* 416–417, 1932.—The previous calculation [see Abstract 3174 (1932)] ignored a term $st\,(c_v - c_p)c_p$, where s is the specific humidity, and c_p, c_p', the specific heats of dry air and water vapour at constant temperature, taking which into account the psychrometer constant becomes $(B - 0{\cdot}76e_m)/(1640 - 1{\cdot}24t_m)$. C. A. S.

968. Clouds. P. Gamba. *Com. Naz. Italiano, Geod. e Geofis., Boll. Nos.* **11–12.** *pp.* 170–173, *Nov. Dec.*, 1932.—This paper summarises briefly the programme for conducting the "Cloud Year," *i.e.*, devoted to the observations of cloud phenomena, simultaneously with the "Polar Year." W. A. R.

969. Climatology: Solar Radiation in Greenland. C. Maurain and J. Devaux. *Comptes Rendus*, 195. *pp.* 985–987, *Nov.* 28, 1932.—This note treats of measurements of solar radiation carried out at Scoresby Sound in Greenland in July and August 1932. The total heats received per sq. cm. are tabulated. The first table contains the mean values per minute at each hour during the first 5 days. The second gives the total heat received per day during the other 17 days of observation. For comparison purposes the mean values obtained from 3 years' observations at Paris (1928–1930) are given in tabular form. The instrument used was a Gorczynski solarigraph with Moll thermopile and Richard self registering voltmeter, which has been previously calibrated at the Parc Saint-Maur Observatory. A. E. M. G.

970. Investigations of the Auroral Spectrum during 1921-26. L. Vegard. *Geofysiska Publ.* **9.** 11. [71 *pp.*] 1932. *In English.*—This report is divided into five chapters. In Chapter I, the author, after referring to previous work on the aurora, deals with the object of the research and the preparations required in the way of instruments. Two types of spectrograph were required (1) to obtain accurate values of certain wave-lengths and (2) to study the variations in the colour of the aurora. Details are given showing how the temperature of the instruments was kept constant. The main observations were carried out at Tromsø. In Chapter II the methods of measurement of the lines in the spectra are first considered, and thereafter the lines obtained with the various kinds of spectrograph are discussed and wave-lengths tabulated. The origin of certain of the lines is considered, the author concluding that none of them can be attributed to hydrogen. He also deals at some length with the probable origin of the strong green line and considers that his results point to nitrogen as the most probable cause. The intensity distribution within the auroral spectrum is dealt with in Chapter III. Now observation shows that this intensity may vary from one display to another for different reasons. So the author points out that it is difficult to speak of any definite distribution of intensity within the auroral spectrum. But as the exposures last over several weeks general types of spectra can be got. These are compared with the spectra of diffused daylight taken on the same plates. The relative intensities of the lines are obtained from the different spectrograms and finally the average intensity distribution derived from all measurements is tabulated and graphed. The effect of atmospheric extinction on the intensity distribution is then discussed and a correcting factor applied to the above tables. The

temperature of the auroral region forms the subject matter of Chapter IV. The methods used for temperature determinations are indicated and the results obtained are discussed. The average temperature of the auroral region is found to be 242° K. or − 31° C. This is shown to be at variance with the results obtained by Lindemann and Dobson. The temperatures found are mean values obtained from exposures lasting over several weeks and considerable variations may therefore take place in the interval. The author considers that his explanation of the origin of the green line need not be abandoned on account of the value found. [see Abstract 2829 1932.)] The various conclusions to be drawn from this research regarding the state of the upper atmosphere occupy Chapter V. Some of these are : In the upper atmosphere (1) The hydrogen-helium layer does not exist ; (2) Nitrogen is a dominating component ; and (3) The auroral line is not emitted from a gas lighter than nitrogen. Turning to the physical state of the upper atmosphere the author shows how the electric intensity and conductivity vary with height and how these variations affect the composition of the different layers. In this way the presence of gases such as nitrogen at high levels is accounted for. Likewise the resulting constitution of the upper strata appears to offer an explanation of the Zodiacal light, and a comparison of the state of the upper atmosphere whither matter is lifted by the electric forces, is made with the composition of the sun's corona. Some remarks are given on the periodic variation of the intensities of the green and red lines, but the author concludes that further investigation is necessary on this point, though he adds that " it is a remarkable fact that the red line was exceptionally strong during 1926 which is near a sunspot maximum." In addition to the text a large number of spectrograms are reproduced. A. E. M. G.

971. Seat of the Plane of Polarisation in the Celestial Vault. A. Sinjagin. *Gerlands Beitr. z. Geophys.* 38. 1. *pp.* 66–96, 1933.—The paper forms a continuation of an earlier one [see Abstract 1765 (1930)], and in it the following questions are considered : (1) the series of general properties common to all isoclines, independent of the values of the solstitial point ($\odot$) is established, and in connection with it a more accurate general isochronous chart of polarisation is given for the case $\odot = 45°$; (2) by the establishment of the general properties of isoclines a preliminary isochronous polarisation chart for the cases $\odot = 30°$, 60° and 89° can be compiled, and a more accurate construction obtained for $\odot = 0°$; (3) the family of neutral lines (isocline 45°) and that of isoclines ($\xi = 90°$) are investigated for all solar altitudes ; (4) consideration of the family of neutral lines leads to a solution of the question regarding the percentage change of positive and negative polarisation of the celestial vault in connection with solar altitude. A curve is given which supplies a complete, though not quite accurate, solution of this problem. For a solar altitude of about 40° the amounts are approximately equal ; (5) it is further considered that the isocline, $\xi = 90°$ for the altitude $\odot = 45°$ becomes a circle satisfying the equation $\cos A = \sqrt{2} \cos H$ but this coincidence is as yet proved only geometrically. R. S. R.

972. Polarisation of Light from the Sky. W. Smosarski. *Gerlands Beitr. z. Geophys.* 38. 1. *pp.* 97–111, 1933.—The polarisation depends on the sun's altitude, the turbidity of the atmosphere and conditions at the earth's surface at the place of observation. Equations are given by which the polarisation of the light from the sky can be expressed

in terms of three rectangular vectors at the point of measurement and formulæ are deduced which give the polarisation and the position of the principal planes of oscillation of any beam of diffused light from the sky. The positions of the neutral points are determined and their variations. It is found that the principal planes of polarisation of a beam should coincide with the planes of symmetry of two planes passing through the beam and the neutral points of the sky. These theoretical relations are then applied to the results of measurements by the author and others but the confirmation is not exact in all cases. The conditions of applicability are discussed. R. S. R.

973. Influence of Ventilation on the Readings of a Wet-Bulb Thermometer. H. Bongards. *Zeits. f. Instrumentenk.* 52. *pp.* 498–505, *Nov., and pp.* 542–548, *Dec.*, 1932.—Discusses the effect of ventilation and of the form of the thermometer bulb, on the readings of the wet-bulb thermometer, with special reference to the boundary layer theory of air flow. A general formula is brought forward, applicable to any air velocity. J. H. A.

974. Radio-Meteorograph. *Nature*, 130. *pp.* 1006–1007, *Dec.* 31, 1932.—Details are given of an improved pattern of Moltchanoff's radio-meteorograph [see Abstract 1540 (1932)]. It consists of a small short-wave radio transmitter located at the middle of a dipole antenna trailing below the balloon. Constant frequency is maintained over the range of temperature and special dry batteries are used to withstand the low temperatures encountered. The transmitter is of normal c.w. type and emits its signals under the control of a contact which makes or breaks its anode circuit in accordance with the elements, pressure, temperature, and humidity, to be signalled. The pointers for these elements are arranged one above the other and move on a circular track. A contact arm (A) is rotated continuously by a clockwork drive and the brush of A makes a fleeting contact in turn with each pointer, a synchronising segment and two fixed contacts, the last three being equally spaced at 120° apart. The time interval between the end of the synchronising signal and the contact with the temperature arm indicates the instantaneous position of the latter, while the other two intervals indicate the positions of the pressure and humidity arms. Automatic recording provides a continuous record, a picture receiver of the rotating cylinder type being used. The instrument weighs 2 kg. and recording ranges up to 100 km. have been obtained.
R. S. R.

975. Simple Instrument for Studying Temperature Inversions in the Free Atmosphere. A. K. Das. *Gerlands Beitr. z. Geophys.* 37. 2-3. *pp.* 224–232, 1932. *In English.*—The apparatus consists essentially of an inverted glass U-tube with the horizontal part connected to a small bulb. The bulb and part of the U-tube contain air, concentrated H_2SO_4 filling the rest of the space. Traps permit the acid to flow only up one limb and down the other limb of the U-tube. With rise of temperature the air expands and at a certain temperature expels the acid on to a mixture of $KClO_3$ and sugar. The apparatus is supported by a balloon ascending at a fixed rate. By observation of the smoke from the explosion and also of a flag released at the explosion the height can be found. The apparatus is normally calibrated to operate for a temperature rise of 3° C but this sensitivity can be varied. Full details of the construction of the apparatus are given. Two ascents are being made daily at Alipore Observatory,

Calcutta, to investigate the origin of temperature inversions and their relation to thunderstorms and allied phenomena. The apparatus costs 3 annas and weighs only 25 gm. [See Abstract 3166 (1932).] R. S. R.

976. Directional Effect of the Single Hot-Wire Anemometer. M. Ziegler. *K. Akad. Amsterdam, Proc.* 35. 8. *pp.* 1067–1077, 1932.—The variation of the apparent air speed V_a with the angle of inclination ϕ of the hot wire to the direction of flow has been determined for true speeds V of 160, 485, and 860 cm. per sec. The results are in conformity with the equation $V_a = V\sqrt{\sin^2\phi + \alpha^2_o \cos^2\phi}$, where α_o is a coefficient of which the values for the speeds given above are 0·275, 0·161, and 0·113, respectively. In general, for a hot wire more than 1 cm. long and speeds above a few m. per sec., the presence of a velocity parallel to the wire does not influence the anemometer reading appreciably ; the parallel component may amount to 1·42 times the normal component before an error of 1 % appears in the indication of the latter. H. F. G.

977. Error in Marking an Aitken Pocket Dust-Counter. V. F. Hess and C. O'Brolchain. *Gerlands Beitr. z. Geophys.* 37. 4. *pp.* 386–389, 1932. *In English.*—The error is in the dilution marks and is considerable, for the instrument examined (diameter of receiver 29 mm.) the distances from the top of the 0·2, 0·1, 0·05, 0·02 and 0·01 marks should be 34·5, 14·5, 6·7, 2·6, 1·3 instead of 39, 20, 10, 4 and 2 mm. respectively. The correct method of calculation is given. The error has been corrected in the Aitken-Luedeling counter. [See Abstract 755 (1931).] C. A. S.

978. Geophysical Station at Mogadiscio. M. Bossolasco. *Com. Naz. Italiano, Geo. e Geofis. Boll. Nos.* 11–12. *pp.* 161–170, *Nov.–Dec.*, 1932.—In an illustrated paper the new Observatory at Mogadiscio, fitted for meteorological, magnetic and electrical observations, is described. W. A. R.

See also Abstracts 890, 921, 923, 986, 987.

SEISMOLOGY.

979. Gravity n the Atlantic Area. F. A. V. Meinesz. *K. Akad. Amsterdam, Proc.* 35. 9. *pp.* 1143–1149, 1932.—The paper gives a preliminary outline of the results obtained by gravity observations and soundings in the Atlantic made in the Dutch submarine O 13 in the summer of 1932. Gravity observations were made by the apparatus used on former surveys, and soundings by the sonic method. The soundings gave deviations from existing charts, and a ridge, not previously charted, was discovered S.W. of the island of Flores. With regard to the gravity observations only general results are available, but it is clear (1) that no strips of negative anomalies were found such as those that exist in the East and West Indies over the seismic part of the crust. This indicates that deformations in the Atlantic crust are different from those in geosynclinal areas ; (2) except in the English Channel all stations show positive anomalies, of which the only explanation seems to lie in the assumption that the earth's crust is able to transmit forces over its whole extent. In the Atlantic a strong compressive stress is assumed. W. A. R.

980. Reflection and Refraction of Seismic Waves. K. Sezawa and K. Kanai. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 805–816, *Dec.*, 1932. *In English.*—A mathematical treatment of reflection

and refraction at stratified boundaries. The movement of the ground due to arbitrary waves is quite similar to that due to harmonic waves of infinite extent. W. A. R.

981. Seismological Station at the Huancayo Magnetic Observatory, Peru. J. A. Fleming. *Seismological Soc. of America, Bull.* 22. *pp.* 263–269, *Dec.*, 1932.—A seismological station has been established with effect from August 22, 1932, at the magnetic observatory at Huancayo, 120 m. east of Lima, Peru, 11,000 ft. above the sea, at 12° 2·7′S., 75° 20·4′W. It is equipped with a Renioff vertical-component and two Wenner horizontal-component seismometers. Only preliminary reductions of seismograms will be made at the station, the records being sent to the U.S.A. Coast and Geodetic Survey for compilation, and then to the Carnegie Institution, Washington, for detailed investigation. C. A. S.

982. Epicentral Time and Surface Structure Determined for the Tango Earthquake, Japan, March 7, 1927. E. A. Hodgson. *Seismological Soc. of America, Bull.* 22. *pp.* 270–287, *Dec.*, 1932.—A more detailed account of the method of determining time, epicentre, and focal depth of the Tango earthquake is given. It is also shown that the surface stratum in which it occurred was only about 16 km. thick, that the velocities of the longitudinal wave in this stratum, below the discontinuity, and about the inner edge of the mantle at its contact with the core, are respectively 6·3, 7·75, and 12·4 km./sec., and that the corrected P-curve is well established save for epicentral distances near 20°. [See Abstract 539 (1933).] C. A. S.

983. Experimental Investigation of Lateral Earth Pressure during Earthquakes. N. Mononobe and H. Matsuo. *Tokyo Univ. Earthquake Research Inst., Bull.* 10. *pp.* 884–902, *Dec.*, 1932. *In English.*—A shaking box containing sand, some 560 kg. in weight, is described with arrangements for measuring the pressure exerted during and after vibration at various points in the two end walls when the box is vibrated perpendicularly to these walls. From experiments detailed it is concluded that (1) the maximum pressure occurs at the beginning of the vibration; (2) static pressure is increased by vibration due to increased settling of the sand; (3) thorough tamping decreases (1); (4) it also causes a maximum pressure somewhat less than the calculated pressure; and (5) the maximum pressure is substantially lowered if the wall can yield. C. A. S.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

984. Electrical Conductivity and Atmospheric Condensation Nuclei during a Voyage to Greenland. C. Maurain and J. Devaux. *Comptes Rendus*, 195. *pp.* 837–840, *Nov.* 14, 1932.—Measurements were carried out in July, August and September, 1932, on the voyage and at Scoresby Sound. The results of the electrical measurements, of which there were 70, show greater values for $(\lambda_+ + \lambda_-)$ and for λ_+/λ_- at Scoresby Sound than on the voyage. The authors attribute various causes for this, *e.g.*, the purity of the air. Some high values obtained near Iceland are attributed to the nature of the rocks. The condensation nuclei are found to be definitely less in numbers in Greenland than on the open sea. These small numbers found in Greenland are shown to correspond with the small numbers found on high mountains of temperate regions. A. E. M. G.

985. Measurements of the Ionic Spectrum in Innsbruck. J. Booij. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 167–174, 1932.—The

author used a method devised by Israel to determine, with the help of a double condenser, the ionic spectrum. Measurements were made in two regions for ions of mean and large size. The spectrum is rather regular, but, as Kähler and Israel found, there are some ions present with a smaller mobility (k) than Langevin ions. In tables are set out the percentage amounts of positive and negative ions in four regions, (1) ultra large ions, $k < 3 \times 10^{-4}$ cm./sec. : volt/cm., (2) Langevin ions, $k = 3 \times 10^{-4}$ to 10^{-3}, (3) large mean ions, $k = 10^{-3}$ to 2×10^{-2}; and (4) small mean ions, $k < 2 \times 10^{-2}$. No essential differences in the distributions of positive and negative ions appear but type (3) always predominates. No strong excess of ions of one sign was found during conditions of föhn to account for föhn illnesses and the cause must lie more in the ionic distribution.

R. S. R.

986. Electronic Bombardment as a Factor in Atmospheric Phenomena. W. M. Cohn. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 198–223, 1932.—Different observations point to the conclusion that electrons are emitted by the sun. Besides the incidental emission of electrons from sunspots or their neighbourhood which are believed to produce auroræ and magnetic disturbances, the possibility of a uniform electron emission from the sun is discussed. These electrons will strike the entire earth's atmosphere. The electrons are supposed to move partly directly, and partly in paths according to the Størmer theory, meeting also the night side of the earth. Former explanations for the blue colour of the sky and for the polarisation phenomena observed, are discussed. A blue glow is obtained in the laboratory, by electron bombardment of solid bodies, gases and vapours, which is unpolarised and emits a continuous spectrum. A theory is developed, based on these observations, by which a blue glow in the higher strata of the atmosphere may be explained. Three atmospheric layers are distinguished in which the following phenomena occur : (1) in the lowest pollution by dust particles produces scattering, as given by Cabannes and others, and also reflection from the largest particles ; (2) in the middle scattering according to the Tyndall-Rayleigh ideas predominates, and (3) in the upper a blue fluorescent radiation arises from electronic bombardment with pressures of 10^{-4} mm. Hg and below. Milne's theory regarding bombardment of the atmosphere by neutral corpuscles is extended, and it is shown that the blue glow may be found with the ions so formed. This theory is applied to such phenomena in the atmosphere as changes of colour in the sky, phenomena of the night sky, formation of ozone, phenomena after volcanic eruptions and night sky clouds. It is shown that a hard component of cosmic radiation may be caused by electron bombardment of the atmosphere. A voluminous Bibliography is given. R. S. R.

987. Ratio of the Number of Uncharged Nuclei to Number of Charged Nuclei of One Sign. C. O'Brolchain. *Gerlands Beitr. z. Geophys.* 38. 1. *pp.* 4–15, 1933. *In English.*—A cylindrical condenser used in conjunction with an Aitken nucleus counter gives the ratio of the number of uncharged to charged nuclei in the atmosphere of the outskirts of Graz, Austria. The result is 2·67 and for the total number of nuclei to uncharged ones is 1·88. These agree with observation at other places under similar conditions. Tables show a progressive decrease in nucleation from winter to summer and also some connection with the prevalence of mist.

H. M. B.

See also Abstracts 954, 959, 977, 978.

RADIOACTIVITY.

988. Analysis of Primary Radioactive Minerals. A. Karl. *Comptes Rendus*, 195. *pp.* 1071–1072, *Dec.* 5, 1932.—Most minerals are decomposed by carbonyl chloride at 500–550° ; Al, Fe, Nb, Ta, Ti and U volatilise as chlorides, while most other elements are converted into non-volatile chlorides, except Si and *Zr* which remain as oxides. Separation is quantitative for artificial mixtures of U_3O_8 with ThO_2, Ce_2O_3 or $BaCO_3$; of crude rare earths with TiO_2 or Nb_2O_5 and Ta_2O_5 ; and of $BaCO_3$ with Nb_2O_5 and Ta_2O_5. To determine Ra the powdered mineral is moistened with solution of $BaCl_2$, dried and subjected to $COCl_2$ at 550°, when all Ra remains behind as $RaCl_2$ which is determined as usual. C. A. S.

989. Absorption of β-Rays by Matter. G. Fournier and M. Guillot. *Comptes Rendus*, 195. *pp.* 1264–1265, *Dec.* 19, 1932.—Using a source of Ra–E containing very little Ra–D, and so practically free from γ-rays, the mass-absorption coefficients, μ/ρ of the β-rays therefrom for platinum and lead are respectively 25·8 and 26·4 as compared with 26·08 and 26·64 deduced from the author's formula $\mu/\rho = 15 + 0{\cdot}142Z$ (Z being the atomic number). [See Abstract 2468 (1932)]. C. A. S.

990. Internal Conversion Coefficient for Radium C. H. R. Hulme. *Roy. Soc., Proc.* 138. *pp.* 643–664, *Dec.* 1, 1932.—Casimir's calculation [see Abstract 583 (1932)] of the internal conversion coefficient I, based on the assumption that the radiation field may be represented by a dipole at the nucleus, has been checked and extended, the actual wave functions being taken instead of the asymptotic expansion [see Abstract 1361 (1932)] ; the effects of the outer shells, exchange degeneracy, and magnetic interaction of the two *s* electrons are neglected, and the result calculated for one electron in presence of a nucleus of charge *Ze*. The results are :

Source.	$h\nu$ in $eV \times 10^{-5}$.	Internal Conversion Coefficient.	
		Calculated.	Experimental.
Ra*C*	17·78	0·0008	0·0016
Ra*C*	11·3	0·0018	0·0062
Ra*C*	8·0	0·0035	—
Ra*C*	6·12	0·0057	0·0061
Ra*B*	3·54	0·0172	(0·10)
Ra*B*	2·43	0·424	(0·25)

I for the L shells has also been calculated giving as approximate result the ratio $I_K : I_{LI} : I_{LII} : I_{LIII} = 6{\cdot}7 : 1 : 0{\cdot}0086 : 0{\cdot}044$. It is concluded that the internal conversion coefficient of γ-rays from the nucleus of Ra*C* is explicable as an ordinary photoelectric effect save as regards the ray with $h\nu = 14{\cdot}26 \times 10^5\ eV$, which seems to be almost completely converted ; also that in some cases the γ-rays are due to transitions where the angular momentum of the nucleus changes by one unit. C. A. S.

991. Theory of Internal Conversion of γ-Rays. H. M. Taylor and N. F. Mott. *Roy. Soc., Proc.* 138. *pp.* 665–695, *Dec.* 1, 1932.—The internal conversion coefficients of Ra*C* and Ra*B* have been calculated on the assumption that the nucleus radiates as a quadripole field, with results which, compared with those in the preceding Abstract, give sufficient agreement with experimental results to make it probable that for many of the γ-ray lines the ejection of electrons is due to ordinary photoelectric absorption, and that if this is the case, a nucleus can radiate either the dipole or the quadripole field, making transitions in which the angular momentum changes by one or by two quanta. It is thence shown that in a nucleus built of protons and electrons moving with comparable velocities transitions resulting in quadripole radiation will not occur, but that if the electrons move fast compared with the protons dipole and quadripole transitions may be equally probable. C. A. S.

992. Theory of Atomic Nuclei. E. N. Gapon. *Zeits. f. Physik*, 79. 9–10. *pp.* 676–681, *Dec.* 15, 1932.—Starting from the Rutherford hypothetical structure for a nucleus, *viz.*, a zone of α particles surrounded by a zone of neutrons, the author develops several relations which afford a test of the hypothesis. These are (1) all isotopes of the one element should have the same number of α particles in their structure, but the number of neutrons should differ; (2) the difference between the mass defects of a pair of isotopes should be equal to that of the neutron which causes the difference and this should be constant for all isotopes of the same element; (3) that the mass defect of the α particle in the nuclei of the isotopes of one element should be constant. A table of values of mass defects is given for such elements as have been measured and the above predictions are confirmed. It is found that the mass defect of the nuclear α particle increases up to krypton and then decreases. It follows that the difference between this defect and the mass defect of a free particle shows a similar variation. A discussion of the possible structures concludes the paper. J. E. R. C.

993. γ-Ray Method for Measuring the Radium Content of Minerals. F. Běhounek. *Zeits. f. Physik*, 79. 9–10. *pp.* 583–594, *Dec.* 15, 1932.—An apparatus is described for the measurement of the radium content of pitchblende residues. It is claimed to be capable of determining the radium content of a material containing $2{\cdot}5 \times 10^{-10}$ gm. of Ra element per gm. ($0{\cdot}1$ % U_3O_8) with an accuracy of $\pm$ 10 %. The absorption of the γ-rays in the material in question was measured, and it was found that considerable error in the estimation of the radium content may be caused by neglecting the variation of the absorption with the percentage of U_3O_8 in the material. W. E. P.

See also Abstracts 1019, 1162.

RADIATION.

ABSORPTION AND TRANSMISSION.

994. Photoanisotropic Effect in Dyes. Part II. T. Kondo. *Zeits. f. wiss. Phot.* 31. *pp.* 185–199, *Dec.*, 1932.—Quantitively examines the influence of the wave-length of the exciting illumination, and the time of illumination, on gelatin and collodion films containing the dyes already shown to give a pronounced Weigert effect. The same experimental arrangement was used as previously employed [see Abstract 180 (1933)], whilst certain typical dyes chosen from those showing dichroism without photographic sensitisation, dichroism with sensitisation, and both dichroism and double refraction, were used. The results show that, for the dyes showing the dichroitic effect only, with decreasing wave-length of the exciting illumination the position of maximum effect moves towards the shorter waves, whilst the wave-length of this maximum does not coincide with the wave-length of the exciting illumination. Metanil yellow was used as the dye showing both dichroism and double refraction, the latter effect only occurring with light of long wave-length. The maximum double refraction obtains when the dichroitic effect is practically zero, whilst the dichroitic effect is a maximum when the double refraction is approximately zero ; decreasing the wave-length of the exciting illumination causes both maxima to move towards the shorter waves. When long wave exciting illumination is used then the dichroitic effect is more pronounced, the reverse being the case if the exciting illumination is in the lower wave-lengths. The concentration of the metanil yellow affects the magnitudes of the two effects, an increase in concentration causing the double refraction effect to increase more rapidly than does the dichroitic effect. Generally, with the dyes examined, the wave-length giving the strongest effect is lower than that for the maximum absorption and decreases with increasing concentration, but for metanil yellow and for benzo-purple collodion films the reverse is obtained. R. C. F.

995. Absorption and Dispersion of Celluloid between 300 and 1000Å. H. M. O'Bryan. *J.O.S.A.* 22. *pp.* 739–750, *Dec.*, 1932.—The linear absorption coefficient of celluloid has been measured between 300 and 1000Å and found to reach a maximum value of $1 \cdot 1 \times 10^6$ per cm. at 800Å where a film 100Å thick transmits 30 %. The reflecting power of celluloid mirrors at various angles of incidence has been measured for six wave-lengths in this region. From these reflection power curves and extinction coefficients, by using Fresnel's equation, the refractive indices have been calculated for these wave-lengths. The dispersion curve passes through unity at 800Å, reaches a minimum at 550Å and is approaching unity again at 400Å. The total absorption between 300Å and 3000Å accounts for 126 electrons per molecule of cellulose nitrate. Exclusive of the *K* electrons of carbon, nitrogen, and oxygen, which show absorption near 40Å, there are 192 electrons per molecule. AUTHOR.

996. Christiansen Filter for Ultra-Violet Radiation. H. Kohn and K. v. Fragstein. *Phys. Zeits.* 33. *pp.* 929–931, *Dec.* 1, 1932.—The filter devised depends on Christiansen's principle that by the suitable choice of a liquid and a transparent solid whose dispersion curves intersect

an optically homogeneous mixture is obtained for the wave-length corresponding to the point of intersection. A mixture of 56 % benzol and 44 % alcohol in combination with amorphous quartz was used, the dispersion curves at 20° C. intersecting at 360$m\mu$. Rise of temperature displaces the point of intersection towards the short waves and the rate of change was determined. A rise of 50° C. above room temperature causes a displacement of 80 $m\mu$. An electrical thermostat was used to obtain constancy of temperature during the tests. The operation of the filter is found by photoelectric and photographic-photometer methods. The spectral region 300–550 $m\mu$ was investigated and the results are shown diagrammatically. It was found to be advantageous to use a long focus lens to concentrate the light source upon the slit, a short distance from lens to filter, and a sufficient thickness of the filter to obtain purity. Wave length regions of 4–6 $m\mu$ can be obtained in the ultraviolet with a maximum transmission of 65 % for long wave ultra-violet light but decreasing to 25 % for waves of 300 $m\mu$.

R. S. R.

997. Spectral Transmission of Filters for Actinometers, Photoelectric Cells and Photometers. K. Büttner and E. Sutter. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 175–197, 1932.—The advantages and disadvantages of the filter method for quantitative spectroscopy over the use of prisms or gratings are first discussed. The methods of measurement involved the use of the double monochromator over the region 240–2900$m\mu$, and all tests were made at room-temperature. For the range 250–550$m\mu$ the results with potassium cells and a thermoelectric element agreed. For measurements of solar and sky radiation the photoelectric cell was connected to an electrometer. *Hg* vapour and Osram band lamps were used as sources of illumination. For measurements of the radiation of sun and sky with actinometers and photoelectric cells for visible and ultra-violet light and photometers the filters were combined and tested. At first, besides the comparisons in front of the sun, regarding the spectral purity of the filters, measurements were made over the whole range. The results of the tests are tabulated and shown in diagrams. To examine their constancy with time the experiments were repeated after 1½ years. Generally the filters have shown the expected constancy, spectral exactness and purity.

R. S. R.

See also Abstracts 843, 998, 1020, 1160.

COLORIMETRY.

998. Colour Definition by the Duboscq Colorimeter. P. Woog and R. Sigwalt. *Comptes Rendus*, 195. *pp.* 1251–1254, *Dec.* 19, 1932.—In the absence of a spectrocolorimeter it is possible to analyse any colour by limiting the spectrum to a narrow region and comparing chosen points with a neutral grey screen and a Duboscq colorimeter. The spectrum is limited by Wratten light filters such as the following :

Screen.	Wave-lengths Transmitted.	Dominant Wave-length.	Colour.
1. D35 H45	4200–4000	4500	Violet.
2. C49 H45	200–5100	4800	Blue.
3. B58 H45	4600–5400	5200	Green-Blue.
4. G15 H45	5100–5400	5350	Green.
5. B58 E22	5600–6000	5750	Yellow-Green.
6. F29	6100–7000	6500	Red.
7. A25 D35	6400–7000	6750	Deep Red.

The author prepares a neutral grey solution by suspending graphite in water containing 0·4 % of sodium silicate, decanted after 14 days with a little thymol or chloroform as an antiseptic. E. E. F. d'A.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

See Abstracts 1051, 1226, 1227.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

999. Structure of Nitrogen and the Different Phosphorescence of the Two Forms of Solid Nitrogen. L. Vegard. *Zeits. f. Physik*, 79. 7–8. *pp.* 471–491, *Dec.* 3, 1932.—Describes the determination of the structure of nitrogen by X-ray analysis. While in α nitrogen the atoms have definite places determined by the space group and the molecular axes have a fixed direction, there is a certain statistical nature about the positions of the atoms in the β state and of the direction of the molecular axes. On the basis of the author's former supposition that the phosphorescence of the α form is associated with radiation from a metastable form, the absence of phosphorescence with the β form is accounted for by the destruction of the metastable state by molecular motion. J. E.

1000. Triboluminescence. S. S. Bhatnagar, K. G. Mathur, and K. L. Budhiraja. *Zeits. f. phys. Chem.* 163. *Abt. A.* 1. *pp.* 8–16, *Dec.*, 1932.—The triboluminescence of arsenious anhydride, saccharin, and uranyl nitrate has been investigated in its relation to temperature, ageing, additions of gelatin and glycerol, and irradiation by short-wave light. The triboluminescence depends greatly on the physical conditions prevailing during crystallisation, *e.g.*, on the temperature and viscosity of the crystallising solution, and also on the size of the crystals. Since no physical or chemical change in the luminescent substances is detectable, the light-emission can scarcely be attributed to chemical changes, although the possibility of reactions between the ions is not completely excluded. It is, therefore, assumed that the crystals, during their formation, include some of the saturated solution, most probably in the colloidal state. The systems thus formed would be unstable, and would become stable only when the included solution crystallises completely. This interpretation is supported by the facts : (1) that large crystals exhibit stronger triboluminescence than smaller ones ; (2) that the change in the triboluminescence becomes slower as the viscosity of the system is increased ; (3) that at high temperatures, which favour coagulation, the velocity of conversion of the fresh arsenious anhydride crystals into the non-luminescent form is greatly increased.

T. H. P.

See also Abstracts 986, 1038, 1064, 1163.

INTERFERENCE. DIFFRACTION AND SCATTERING.

1001. Theory of Critical Opalescence. Y. Rocard. *Comptes Rendus*, 195. *pp.* 771–773, *Nov.* 7, 1932.—The author outlines a new theory of critical opalescence in which instead of assuming the internal pressure P_i to equal the van der Waals expression $-a/v^2$, a correction term is added to take account of the non-uniformity of density which must exist in an opalescent fluid. The anomaly in earlier theories that exactly at the critical point the intensity of diffuse light should be infinite, is here avoided. A similar theory can be developed for the scattering of light by a binary

mixture at the critical point of complete miscibility. Values for the intensity of the scattered light, of the same order as those observed experimentally, are given by the theory. W. S. S.

See also Abstracts 886, 1024, 1031, 1074, 1145.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

1002. Inhibition of Photochemical Decomposition of Ammonia by Atomic Hydrogen. H. W. Melville. *Faraday Soc., Trans.* 28. *pp.* 885–889, *Dec.*, 1932.—A mixture of ammonia, hydrogen and mercury vapour in a silica globe was illuminated by (*a*) a zinc spark ; (*b*) the spark simultaneously with a water-cooled mercury arc lamp; and (*c*) the arc alone. The arc (*c*) caused no decomposition of NH_3, but a production of atomic H by the action of activated Hg on H_2. With (*a*) much more NH_3 was decomposed than with (*b*). It is concluded that NH_3 decomposes photochemically to $NH_2 + H$ [see Abstract 3487 (1932)], and that in (*b*) this reaction is checked by mass action, due to the additional atomic H produced by the arc. Removal of atomic H by CO would explain the accelerating effect of CO on the photochemical decomposition of NH_3 reported by Emeléus [see Abstract 2639 (1932)]. C. A. S.

1003. Photochemical Decomposition of Phosgene Vapour. F. Almasy and T. Wagner-Jauregg. *Zeits. f. phys. Chem.* 19. *Abt. B.* 6. *pp.* 405–419, *Dec.*, 1932.—With irradiation of $\lambda < 2750$Å, the dissociation of the phosgene molecule is confirmed from spectroscopic data. Excitation by radiation of $\lambda = 2750$ to $\lambda = 3050$ Å produces an appreciable decomposition of phosgene vapour. The temperature dependence of the spectrum and of the photochemical decomposition is investigated. H. H. Ho.

1004. Yellowness in Sepia Toning. E. E. Jelley. *Kodak Research Lab., Comm. No.* 503. *Phot. J.* 72. *pp.* 480–485, *Dec.*, 1932.—Examines the cause of yellowness which can occur when a two-solution method of sepia toning has been used. Sodium sulphide is oxidised by the air to yield sodium thiosulphate, and when a solution containing both such salts is added to potassium ferricyanide the sulphide is destroyed whereas the thiosulphate is not. Thus when a bleached plate containing ferricyanide is placed in a stale sodium sulphide solution some of the sulphide is destroyed, leaving the silver halide first subjected to the solvent action of the thiosulphate. The sulphide only diffuses into the emulsion when the ferricyanide is exhausted and the silver sulphide which then forms is colloidal and the print yellowish. Only perfectly fresh sodium sulphide solutions give good toning with prints containing ferricyanide, but if all the ferricyanide is removed, good results are obtained with very stale sulphide solutions. Further, the sulphide changes the ferricyanide to ferrocyanide which changes to cyanide, and this is still more potent in producing the yellowish tones. The addition of 1·5 % of sodium carbonate crystals to the ferricyanide bleaching solution considerably helps the removable, by washing, of the ferricyanide, and does not affect the stability or rapidity of action of the bleach. R. C. F.

1005. Nuclear Activation. Lüppo-Cramer. *Zeits f. wiss. Phot.* 31. *pp.* 200–202, *Dec.*, 1932.—Plates treated in a manner previously described [see Abstract 2672 (1931)] are first peptised by means of a sodium carbonate solution, and after illumination through a neutral wedge, some are placed

in an alkaline solution, whilst others are left untouched. A comparison shows that this alkaline treatment raises the sensitivity of the plates. Treatment of the two groups of plates with an acid potassium bromide solution shows, after development, that fogging is produced on the plates which were placed in the alkaline solution. This is due to the large nuclear activation brought about by such treatment, which also gives rise to a destruction of the latent image. Similar results are obtained if solutions of potassium bromide and hydrogen peroxide, and a 2 % solution of ammonium persulphate are used, whilst the peptising can be performed in a 1 % ammonia solution. R. C. F.

1006. Desensitising Sensitisors. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 31. *pp.* 203–207, *Dec.*, 1932.—Experiments are described which indicate the decrease of the desensitising effect of capri-blue with dilution, *i.e.*, an optical sensitising occurs. Similar results are recorded for erythrosine and methylene blue. H. H. Ho.

1007. Lattice Disturbance. Lüppo-Cramer. *Zeits. f. wiss. Phot.* 31. *pp.* 208–209, *Dec.*, 1932.—This paper continues the author's work [see Abstracts 2823 and 2827 (1932)] on the influence of thallium iodide on photo-sensitive salts, and contains directions for the preparation of a very sensitive plate composed of the iodides of mercury and thallium suitably dispersed. H. H. Ho.

1008. Hypersensitisation: Part III. Influence of Silver Ions on the Spectral Sensitivity of Silver Bromide Plates containing Dyestuffs. J. I. Bokinik and Z. A. Iljina. *Zeits. f. wiss. Phot.* 31. *pp.* 210–215, *Dec.*, 1932.—This paper continues previous work [see Abstract 3240 (1932)] and investigates the spectral distribution of the greatly increased sensitivity produced upon silver ions by the presence of sensitising dyestuffs. Data are given for the following colouring matters: pinacyanol, pinachrome, erythrosine, fuschine, methylene blue, crystal violet, auramine, pinacryptol (yellow and green), acid-fuschine, fast blue, and crystal ponceau. The effect is greatest in the presence of basic dyestuffs, but is absent with acid dyestuffs which do not alter the general and colour sensitivity of silver bromide. H. H. Ho.

1009. Standards of Light for Photographic Sensitometry. (Miss) P. Lévy. *Soc. Franç. Phot. et Ciné., Bull.* 19. *pp.* 198–205, *Oct., and pp.* 223–234, *Nov.*, 1932.—Describes in detail the various sources of light which might be used as standards for sensitometry. After a consideration of the sources operating at the lower colour temperatures, the author refers to the Forrest (plain carbon, double positive) arc (temperature, 3700° K.; brightness 176 candles per sq. mm.), and burning magnesium (temperature, 3700° ± 75° K.) either with or without colour filter. The acetylene flame and the special burners designed for use with it are next described. Finally, the author describes the standards proposed by the Royal Photographic Society and the form in which these were adopted by the International Photographic Congress. The actual source is a tungsten filament lamp, under-run to a colour temperature of 2360° K, and this may be used with a filter designed to change the spectral distribution to a close approximation to noon sunlight. Various filters have been suggested and these are described in the paper. In the concluding paragraphs the suggestion is made that a certain type of gaseous discharge tube may be found suitable as a standard. J. W. T. W.

1010. New Sensitometer for Sensitivity Measurements. H. Göthel and W. Seifert. *Phot. Indust.* 30. *pp.* 1275–1278, *Dec.* 28, 1932.—Describes in detail the construction of a new sensitometer built to fulfil two principal requirements which are not satisfied by the usual methods used to-day. The method of measuring the testing strips in order to arrive at the sensitivity number of the emulsion is also given. R. C. F.

See also Abstract 994.

PHOTOMETRY.

1011. Photoelectric Measurement of Faint Light. G. L. Locher. *Phys. Rev.* 42. *pp.* 525–546, *Nov.* 15, 1932.—Describes extremely sensitive detectors for measuring very faint light within the range 0·9 to 7·5 μ. These consist of a combination of a photoelectric cell with a Geiger-Müller counter so that the photoelectrons are counted individually. Various sensitive surfaces are used for measurements in different parts of the spectrum, the most sensitive for the visible being potassium hydride on mercury. The mode of construction and the operation of the tubes are described, as well as methods of sensitising with various dyes. With some of the tubes, photocurrents as small as 0·05 electron per sec. can be measured. Amplifying and recording apparatus is described which is suitable for counting as many as 100 electrons per sec. The paper also discusses criteria for determining the useful electron-counting sensitivity of a counter, the factors limiting its counting speed, and an explanation of its mode of operation. A counter was used to compare the total ultra-violet radiations from several light sources. A quartz mercury arc taking 120 watts gave 6 million times as much ultra-violet as a 1000-watt gas-filled projector lamp. J. W. T. W.

1012. Apparatus for the Rapid Measurement of Micro-Photograms. J. Wouda. *Zeits. f. Physik*, 79. 7–8. *pp.* 511–515, *Dec.* 3, 1932.—Apparatus comprising two parts, *viz.*, (1) an electrical device for determining the relative darkness of the respective parts of a spectral line, and (2) an optical arrangement for converting the determinations so made into relative intensities, is described. J. S. G. T.

See also Abstracts 923, 926, 997.

POLARISATION.

1013. Photoelectric Polarimetry. Measurements of Rotatory Dispersion of Some Sugars. G. Bruhat and P. Chatelain. *J. de Physique et le Radium*, 3. *pp.* 501–511, *Nov.*, 1932.—Following their previous discussion of the conditions to be fulfilled for accurate work [see Abstract 4933 (1932)] the authors describe an apparatus, involving a doubly refracting analyser combined with a photoelectric cell (sodium or potassium in quartz) and a d.c. amplifier, which allow rapid measurements to be made; for a rotation of the order of 45° the error is about 1 in 400. Wave-lengths down to 3021Å could be used. The instances tested include saccharose, glucose and lævulose. The results are in good agreement with the values given by the formula with which Lowry represented his photographic results, which do not, however, go below 3826Å. The method here described enables the authors to make their measurements in the ultra-violet region as rapidly as the best methods for the visible region.

H. L. B.

1014. Racemisation of Mandelic Acid. A. N. Campbell and Alexandra J. Campbell. *Am. Chem. Soc., J.* 54, *pp.* 4581–4585, *Dec.*, 1932.—Measurements of the velocity of racemisation of mandelic acid in HCl and NaOH solutions show that the rate is greater in the latter, and in both greater than that of Rochelle salt. No systematic variations in the constant are observed, and there is no evidence of any mechanism other than the simple transition of *l* to *d* forms. Hydroxyl-ion concentration and conductivity measurements give no evidence of complex formation, and no complex could be isolated. The racemisation in strong HCl solution is accompanied by some decomposition, free chlorine being liberated. The decomposition product is possibly phenylacetic acid. [See Abstract 206 (1933).] C. B. A.

1015. Optical Activity and Valence Theory. C. H. Johnson. *Faraday Soc., Trans.* 28. *pp.* 845–856, *Dec.*, 1932.—Optical isomerism is only observed in co-ordination compounds when the co-ordinated groups are attached to the central ion by covalent bonds. No resolution is possible if the components of the molecular ion are united by ionic bonds. This can be used as a criterion for determining the valency characteristics of co-ordination compounds. Work bearing on the subject is reviewed and tentative explanations of the failure to demonstrate optical isomerism in complex salts of the ionic type are suggested. The resolution of $K_3Fe(C_2O_4)_3$ and $K_3Al(C_2O_4)_3$ previously reported by other workers is not confirmed, and attempts to resolve $K_3Mn(C_2O_4)_3$ have so far proved fruitless. It is inferred that these complex ions are stabilised by ionic linkages, and this is confirmed by the magnetic susceptibilities of the ferri and mangani salts. The optical activity criterion, while giving identical results with the magnetic criterion, will also furnish results when the latter is inapplicable, as in the case of Cr^{+++} complexes, etc. C. B. A.

See also Abstracts 971, 972, 1071.

RADIATION, EMISSION.

1016. Radiation from Incandescent Oxides and Oxide Mixtures in the Visible Spectrum. H. Hoppe. *Ann. d. Physik*, 15. 6. *pp.* 709–728, *Dec.*, 1932.—Liebmann has given a method for measuring the temperature of a single incandescent oxide [see Abstract 196 (1931)]. A similar method is employed in the present paper to determine the emissivity of oxide mixtures in compact form by means of exact temperature determinations. The emissivity of the oxides and their mixtures as determined individually is related to the temperature, grain size, compactness and wave-length in the visible spectrum. In all cases, both for pure oxides and their mixtures, the decrease of grain size (from about 1 μ) results in a diminution in the emissivity. With the exception of chromium oxide, all the others examined, both alone and in mixture, increase in emissivity with rise of temperature in the red. In the case of aluminium chromium oxide mixtures a logarithmic relationship exists between the chromium oxide content and the emissivity in the red, but this relationship does not exist for thorium/cerium oxide mixtures. In the violet end the addition of a small quantity of chromium oxide to aluminium oxide gives an emissivity for the mixture only about one-half that of the pure aluminium oxide. The temperature method is further developed by the use of white sapphire and ruby crystals, and the emissivity of these two crystalline bodies is

fully investigated, particularly in so far as they affect the temperature measurement. S. G. B.

1017. Total Radiation from Heated CO_2. T. Dreisch. *Zeits. f. Physik*, 79. 11–12. *pp.* 711–721, *Dec.* 30, 1932.—Taking precautions to avoid error due to the presence of comparatively cold CO_2, the author finds the total radiation from the gas between 300° and 900° C. amounts to $7{\cdot}41 \pm 0{\cdot}213$ % of the radiation from a perfectly black body at the same temperature. The total radiation varies as the fourth power of the absolute temperature. J. S. G. T.

1018. Registered Observations of Cosmic Radiation. J. A. Priebsch and R. Steinmaurer. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 296–314, 1932.—An account of observations made between Oct., 1929, and Nov., 1930, on the summit of the Hohen Sonnblick, 3106 m. above sea-level. Two apparatus of the Kolhörster loop-electrometer type were used successively together with a photographic self-recording device of Hess and Mathias giving automatic readings at every hour from 6 a.m. to 3 a.m. next day. Screening by iron plates 7 cm. thick either all round or the same but open above (half-screening) was used. The absolute values of the intensity of the radiation (with barometer reduction) were 8·00 J half screened and 6·13 J fully screened. The coefficients giving the variation of the ionisation with the barometric pressure are 0·05 J per mm. Hg. (half-screened) and 0·03 J per mm. Hg. (fully-screened). The monthly means of the ionisation in both cases show a marked seasonal period with an amplitude of $\pm$ 2 % with higher values in summer and lower values in winter, in agreement with Steinke's observations in Königsberg. There is also a daily period with a maximum in the late evening and a minimum in the forenoon. There is a slight indication of the sidereal time period in observations of March and April, 1930, but otherwise no variations with sidereal time were noticed. J. J. S.

1019. Cosmic Rays. T. H. Johnson. *Frank. Inst., J.* 214. *pp.* 665–689, *Dec.*, 1932.—A summary of the work of various observers as well as of investigations by the author. An apparatus for recording triple coincidences designed by Johnson and Street is described. This is a modification of the Geiger-Müller counter arrangement using several tubes, so that only simultaneous discharges are recorded and thus an automatic cosmic ray telescope is formed which counts the rays passing through it, undisturbed by radium rays. Observations with this on the top of Mt. Washington and at Hiram, in Maine, near by, at 600 ft. showed not only a faster counting rate at the greater height but a different distribution about the vertical. Anderson's experiments in which he bent rays of energies of 600 million volts are referred to. In one of Anderson's photographs two rays have apparently a point of common origin in the metal walls of the chamber, showing that either one or both of these rays are secondary rays. Schindler measured by the ionisation method the current produced by the cosmic rays after they had passed through various thicknesses of absorbing material. His results indicate that the interaction of the cosmic rays with matter is a nuclear phenomenon. The explosions which have been observed in the ionisation chamber by various investigators may mean that a cosmic ray has been able to liberate at one time from the surrounding nuclei one thousand secondary rays, each perhaps having energies of the order of ten million volts. J. J. S.

1020. New Monochromatic Radiator. K. Wernicke. *Zeits. f. techn. Physik*, 13. 12. *pp.* 616–617, 1932.—A new type of sodium vapour discharge lamp is described. A glass globe contains the two electrodes in an atmosphere of argon. For mechanical protection and constancy of temperature an outer glass globe is provided. The lamp is almost completely monochromatic, the red and green lines of the Na spectrum having an intensity only about 1 % of that for the D-line and they can be eliminated. The lamp has a useful illuminating surface of 10 × 15 mm. and an intensity of 4 — 6 HK/cm². which is nearly 20 times as great as that of any former type. It acquires its maximum intensity after 2–3 min., and there is only a slight gradual decrease with age, while for a series of tests its intensity is constant. R. S. R.

See also Abstracts 986, 1162.

RADIATION, GENERAL THEORY.

1021. Radiation from Slow Electrons. L. Nedelsky. *Phys. Rev.* 42. *pp.* 641–664, *Dec.* 1, 1932.—Expressions are obtained for the radiation emitted by an electron in the field of a neutral atom ; the model assumed for the neutral atom is a point-charge Ze surrounded by a spherical shell of radius a carrying a charge $-Ze$. The physical foundations of the problem are carefully set out. Expressions are obtained for the matrix components of the acceleration, and methods are given for evaluating the integrals that result. This makes it possible to compute the density of radiation and the polarisation. For heavier elements and low-velocity electrons the intensity of radiation is independent of Z and nearly proportional to Va^2, where V is the energy in volt-electrons. For lighter elements the intensity of radiation exhibits a striking series of maxima and minima (for slow electrons). It is also shown that the radiation from protons in the field of the model is simply related to the radiation from electrons in the field of an unscreened nucleus. The authors discuss how Z and a are to be chosen in order that a nuclear model may represent an actual atom so that the experimental findings are in agreement with the theory. H. L. B.

RADIATION, MECHANICAL EFFECTS.

1022. Photophoresis of Silver Particles. A. Lustig and A. Söllner. *Zeits. f. Physik*, 79. 11–12. *pp.* 823–842, *Dec.* 30, 1932.—Fifty silver particles of an average size of 10^{-5}cm. were examined for their photophoretic relations. Some were light-positive, others light-negative, while some had no photophoresis. Under a constant fall-velocity most of the particles altered their photophoretic power, a process which was accelerated by intense light. Some light-negative particles became light-positive during the measurements. The sizes of these differently-behaving particles, tested by Kármán's method, were appreciably the same. A. D.

REFLECTION. REFRACTION AND DISPERSION.

1023. Reflection and Refraction by Transparent Materials. W. Hartwig and A. Johnsen. *Zeits. f. Krist.* 84. *pp.* 14–19, *Dec.*, 1932.—The dependence on refractive index and angle of incidence of the amount of light reflected from several transparent minerals is calculated from Fresnel's formula. Two conditions concerning the angle of incidence and the refractive index are formulated. When both are satisfied, the amount of reflected light passes first through a maximum and then through a

minimum as the refractive index increases. When both conditions are not satisfied the amount of reflected light continually increases with increasing refractive index. J. T.

1024. Image Formation of Non-Self-Luminous Objects. C. Münster. *Ann. d. Physik*, 15. 6. *pp.* 619–644, *Dec.*, 1932.—The paper discusses the difference between the appearance of images of self-luminous and non-self-luminous objects and the conditions under which the difference is insignificant, with particular reference to the image of a slit seen through a double-slit aperture. It is concluded that an object will appear as if it were non-self-luminous if the phase variation in the entrance pupil is small compared to the wave-length and as self-luminous when the phase variation is large. Apparatus is described by which the distribution of light in interference images can be observed visually and photographically and be adjusted to correspond to the stages between an apparently non-self-luminous to a self-luminous object. Measurements on interference images formed under various experimental conditions are given. W. D. W.

1025. Specific Exaltation of Molecular Refraction and Dispersion. E. Hückel. *Zeits. f. phys. Chem.* 163. *Abt.A.* 1. *pp.* 67–69, *Dec.*, 1932.—It is shown that the so-called "specific" exaltations of molecular refraction and dispersion, which are obtained from the corresponding true exaltations by division by the molecular weight, are not characteristic quantities for a molecule as are the true exaltations, so that the latter must always be employed. C. B. A.

1026. Refractive Indices of Liquid Mixtures with Benzene as one Component. N. A. Puschin and P. G. Matavulj. *Zeits. f. phys. Chem.* 162. *Abt.A.* 6. *pp.* 415–418, *Dec.*, 1932.—The refractive indices of solutions of various phenols and amines in benzene have been measured, and it is found that in nearly all the cases the refractive index–concentration curve is convex towards the concentration axis. This is most easily explained by a decrease in the degree of association of the associated substances on solution in benzene. C. B. A.

1027. New Empirical Formula for the Determination of Indices of Refraction. A. Biot. *Ann. Soc. Sci. de Bruxelles*, 52. *pp.* 177–185, *Dec.* 12, 1932.—The new formula

$$n = n_0 + \frac{c_1}{\lambda - \lambda_0} + \frac{c_2(\lambda - \lambda'_1)\ (\lambda - \lambda'_2)\ (\lambda - \lambda'_3)}{(\lambda - \lambda_0)^2\ (\lambda - \lambda'_0)}$$

represents the indices at least as accurately as that of Hartmann and the calculation of the five constants, n_0, c_1, c_2, λ_0, λ'_0 is much simpler. The first two terms on the right-hand side of the equation represent Cornu's formula; with the correction introduced by the third term the error becomes negligible even in the fifth decimal place in the total wave-length interval considered. W. D. W.

1028. Dispersion with Triple-Prism Combinations. H. R. Schulz. *Zeits. f. Instrumentenk.* 52. *pp.* 550–552, *Dec.*, 1932.—For the deduction of the general behaviour of prism combinations the assumption is made that the prism angle as well as the angle of coincidence should be small. On the other hand the inadmissibility of the application of this conclusion in the case of finite angle has been noted. In fact, with the assumption of finite angle peculiarities may be observed which with simplifying hypotheses are in general not discoverable and only with difficulty

by the use of strict expressions on account of these formulæ being rather obscure. A special case is considered and discussed. Since the choice of the kind of glass remains free practically all the conditions can be satisfied which appear in the case of various kinds of prism devised with the object of avoiding the chromatic errors of doubly refracting prisms.

J. J. S.

1029. Relation between the Composition and the Density and Optical Properties of Glass. Part I. Soda-Lime-Silica Glasses. G. W. Morey and H. E. Merwin. *J.O.S.A.* 22. *pp.* 632–661, *Nov.*, 1932.—Measurements of the density and optical properties have been made on 185 glasses of known composition in the ternary system, Na_2O — CaO — SiO_2, well distributed over the composition range from mixtures intermediate between the orthosilicate and metasilicate ratios to pure silica. The measurements include both unannealed and annealed glasses, and a special study was made of the effect of heat treatment on the properties of the glasses. Optical measurements include the refractive index, n_D, dispersion, $n_F - n_C$, and in addition measurements of partial dispersion on glasses of extreme types. The relations between composition and properties are discussed, and it is concluded that no justification exists for an assertion that definite compounds exist in, and determine the properties of, the glasses. The specific refractivity as calculated on the hypothesis of additivity has been calculated by means of the Gladstone-Dale, Lorentz-Lorenz, Eykman, and Lichtnecker formulæ, and the same general pattern of percentage departure was found for all the formulæ tested, the least departure being given for the Gladstone-Dale formula.

W. D. W.

1030. Deformations of Large Astronomical Mirrors. A. Couder. *Bull. Astronomique*, 7. 6. *pp.* 201–281; 7. 7. *pp.* 283–312, *and* 7. 8. *pp.* 353–381, 1932.—The paper discusses and analyses the two principal causes of the deformations of the large mirrors used in reflecting telescopes. These are the flexion due to the weight of the mirror and that due to non-uniform temperature effects. Chapter I.—The significance of the deformations in relation to the Rayleigh $\lambda/4$ tolerance are considered and the minute hysteresis and viscous deformations that may be present and the distortion due to the component of the weight acting perpendicularly to the optical axis, are shown to be negligible. The effect of the component parallel to the axis is analysed and it is shown that for a glass mirror 1 m. in diameter and 10 cm. thick, spherical aberration just greater than the tolerance is introduced when the mirror is in a horizontal plane and astigmatism 8 times the tolerance at an inclination of 45°. The most suitable materials are investigated on the basis of their density and elasticity and the flexibility of various sizes of mirror, where $(\text{radius})^4/(\text{thickness})^2$ is an indication of the flexibility for a given type of support, is discussed. Chapter II.—The errors introduced by mechanical deformation during the manufacture of the mirrors are described and improved methods of mounting the mirror for testing purposes with its axis horizontal are indicated. The best methods of mounting the mirror in the telescope to reduce the flexions to a minimum are discussed and the correct relation between diameter and thickness for different types of mounting given. The mounting of the two mirrors of a reflecting telescope relative to one another is discussed. Chapter III.—Three thermal effects are analysed, namely, the change in focal length, the accompanying spherical aberration

and the disturbances due to convection currents close to the mirror surface. The change of focal length due to temperature differences in the mirror are analysed theoretically and experimentally and the increase, with the thickness of the mirror, of the time required to attain a temperature equilibrium is investigated. Only a small part of the spherical aberration is ascribed to the different temperature gradients at the centre and edge of the mirror and to the isothermal surfaces not being parallel to the surface of the mirror ; the majority is apparently due to the different cooling of the air at the centre and edge of the mirror. The mounting should be designed to reduce this effect by providing suitable ventilation, which may be usefully aided by the employment of electric fans. The author considers that the majority of the scintillation of the image is due to the convection currents of air near the mirror surface and makes various tentative practical suggestions for improvement in the construction of the mirror mounting to increase the ventilation and the circulation of the air. Experiments on a pyrex mirror with a flange at the edge and on metal mirrors provided with a thin glass surface, are described. Chapter IV.—The effect in a telescope objective of the double refraction that usually exists in large discs of glass is discussed and analysed. The normal birefringence is found to be symmetrical about the optical axis and the retardation increases parabolically with the distance from the centre of the lens. This produces a slight astigmatic effect on the image and a tolerance of $\lambda/5{\cdot}5$ in the total path difference at the edge may be allowed. The analysis of the strains show that they would be caused during the cooling of the glass disc, if the edge was always at a slightly lower temperature than the centre. Experiments to correct this are being conducted. W. D. W.

1031. Geometry of the Jamin Refractometer. S. E. Green. *Phil. Mag.* 14. *pp.* 1090–1102, *Dec.*, 1932.—An investigation of the orientation of the plates of a Jamin refractometer which is necessary in order that white-light bands may be observable in the telescope without the use of a compensator. A relation is deduced which is satisfied by the orientations of the plates (for small displacements from the zero positions) whenever the central fringe of the white-light system lies on the intersection of the telescope cross-wires. C. B. A.

1032. Optical Screen for Demonstrations. J. H. Howey. *Rev. Sci. Instruments*, 3. *pp.* 777–781, *Dec.*, 1932.—A new optical screen has been designed for making rays of light visible to large lecture classes. The rays are made to strike obliquely across the screen, making a small angle with the plane of the screen. The behaviour of rays of light incident on mirrors, lenses and prisms can be conveniently demonstrated by using the ordinary forms of these optical devices without any special mountings. On account of the efficient utilisation of the available light, this screen makes possible a large size pattern of the paths of the rays so that the pattern can be observed from all parts of a large lecture room. The rays of light are in full view of both the demonstrator and the class at all times. Author.

See also Abstracts 843, 994, 995.

SPECTROSCOPY.

1033. Band Spectra of MgO, CaO and SrO. P. C. Mahanti. *Phys. Rev.* 42. *pp.* 609–621, *Dec.* 1, 1932.—New measurements of the wave-lengths of the band heads attributed to the oxides of Mg, Ca and Sr

have been made from moderate dispersion spectrograms. For each of these molecules the bands have been classified into two systems. The equations of the band heads in terms of half-quantum numbers for the different systems are as follows :

MgO, red bands, $\nu = 16{,}418{\cdot}06 + \{821{\cdot}95(v' + \frac{1}{2}) - 4{\cdot}05(v' + \frac{1}{2})\}^2 - \{665{\cdot}74(v'' + \frac{1}{2}) - 4{\cdot}41(v'' + \frac{1}{2})^2\}$;

MgO, green bands, $\nu = 19{,}944{\cdot}82 + \{811{\cdot}67(v' + \frac{1}{2}) - 3{\cdot}74(v' + \frac{1}{2})^2\} - \{771{\cdot}42(v'' + \frac{1}{2}) - 4{\cdot}81(v'' + \frac{1}{2})^2\}$;

CaO, blue bands, $\nu = 23{,}817{\cdot}62 + \{726{\cdot}53(v' + \frac{1}{2}) - 11{\cdot}66(v' + \frac{1}{2})^2\} - \{811{\cdot}28(v'' + \frac{1}{2}) - 6{\cdot}60(v'' + \frac{1}{2})^2\}$;

CaO, ultra-violet bands, $\nu = 28{,}849{\cdot}13 + \{565{\cdot}06(v' + \frac{1}{2}) - 4{\cdot}48(v' + \frac{1}{2})^2\} - \{725{\cdot}37(v'' + \frac{1}{2}) - 3{\cdot}56(v'' + \frac{1}{2})^2\}$;

SrO, blue bands, $\nu = 24{,}702{\cdot}81 = \{519{\cdot}09(v' + \frac{1}{2}) - 3{\cdot}50(v' + \frac{1}{2})^2\} - \{653{\cdot}47(v'' + \frac{1}{2}) - 4{\cdot}02(v'' + \frac{1}{2})^2\}$;

SrO, ultra-violet bands, $\nu = 28{,}622{\cdot}18 + \{497{,}81(v' + \frac{1}{2} - 5{\cdot}97(v' + \frac{1}{2})^2\} - \{679{\cdot}13(v'' + \frac{1}{2}) - 9{\cdot}13(v'' + \frac{1}{2})^2\}$.

AUTHOR.

1034. Displacement of the PP-Combinations in the Sodium-Arc Spectrum and its Interpretation. H. Bartels. *Zeits. f. Physik*, 79. 5–6. *pp.* 345–369. *Nov.* 26, 1932.—The PP-combinations in the sodium-arc spectrum are measured from the 6th to the 18th member, and the observed frequencies are compared with those deduced from the principal series on the combination principle. The displacements which are thus found are interpreted as quadratic Stark effects in the internal field. On this interpretation it is found that the effects for the higher terms increase much more slowly than is to be expected from formulæ based on the effects in the lower members of the series. From 10P upwards, the quadratic Stark effects increase with about n^3. C. B. A.

1035. Spectra Na IV, Mg V, Al VI and Mg III, Al IV in the Extreme Ultra-Violet. J. Söderqvist. *Zeits. f. Physik*, 79. 9–10. *pp.* 634–641, *Dec.* 15, 1932.—The vacuum spark spectra of sodium, magnesium and aluminium are photographed as described in previous papers [see Abstracts 4309 and 4310 (1932)]. The lines of the above-mentioned spectra are identified and analysed into term-schemes. J. E. K.

1036. Pole Effect of Iron. Magdalena Adam. *Ann. d. Physik*, 15. 5. *pp.* 568–612, *Dec.*, 1932.—The pole effect of iron (small displacements in wave-length of certain lines in the light emitted close to the poles of an iron arc burning at atmospheric pressure) is subjected to an extended experimental study. The Stark effect of iron measured by the kathode layer method is found to appear for just those lines which show the pole effect. For a low current iron arc the pole effect at the kathode was the same for currents of 0·18 and 0·5 ampere and agreed with other workers' results at 6 amperes. At the anode the pole effect was found to be absent for currents of less than 1 ampere. The regularities in the pole effect of the *d* lines of iron were investigated, and it was found (*a*) that the average pole effect of different multiplets decreases with increase in the average wave number ; (*b*) that the effect can be represented as a difference of individual displacements associated with the two combining terms ; (*c*) that within a series the pole effect progressively decreases ; and (*d*) that on the average to smaller inner quantum numbers corresponds a smaller pole effect.

W. S. S.

1037. Iron Spectrum in the Hydrogen Flame. Magdalena Adam. *Ann. d. Physik*, 15. 6. *pp.* 613–618, *Dec.*, 1932.—The iron spectrum in the hydrogen flame was studied in the visible and in the ultra-violet. It was found that the lines of lower excitation levels (*a* lines) were more intense, compared with the lines of higher excitation levels (*b* lines), than in the spectrum of the iron arc. W. S. S.

1038. Characteristics of the Metallic Spectra Excited by Active Nitrogen. H. Hamada. *Tohoku Univ., Sci. Reports*, 21. *pp.* 554–563, *Dec.*, 1932. *In English.*—In the metallic spectra excited by active nitrogen, no evidence of the resonance enhancements of the lines due to collisions between the metallic atoms and either the metastable atoms or metastable molecules in the active nitrogen was found. The concentration of metastable atoms or molecules must therefore be very small if they are present at all. The mean translational energy, which the sodium atom and the nitrogen molecule possess in triple collisions, is calculated from a measurement of the half-value width of the D-line excited by active nitrogen. It is inferred from this and from observations of the intensities of metallic spectra excited by active nitrogen, that the chief distinction between such metallic spectra and those excited by other means is that in the former case the probability of exciting the lines corresponding to the lower energy levels is much greater than for the higher levels. The intensity distributions in the metallic spectra excited by atomic hydrogen are discussed. J. E. K.

1039. Influence of Temperature on Absorption in the Far Ultra-Violet for Aqueous Solutions of Hydrogen Chloride. R. Trehin. *Comptes Rendus*, 195. *pp.* 1269–1271, *Dec.* 19, 1932.—The absorption spectrum of aqueous HCl solutions has been measured at temperatures from $-10°$ C. to $+90°$ C. and for concentrations from 0·01 to 14 mol. per litre, at the wave-lengths 2816, 2230 and 2170Å. The results are given in tables. J. H. A.

1040. True and Apparent Distribution of Intensity in Spectral Lines. H. C. Burger and P. H. van Cittert. *Zeits. f. Physik*, 79. 11–12. *pp.* 722–730, *Dec.* 30, 1932.—The apparent distribution of intensity $S(y)$ in spectral lines is related to the true distribution W and the instrumental distribution A by the integral equation $S(y) = \int_{-\infty}^{+\infty} W(x)\, A\, (y - x)\, dx$. A method of solving this equation is discussed, and an optical method of effecting the associated integration is described. J. S. G. T.

1041. Fine Structure of Arc Lines of Tin and Lead. S. B. L. Mathur. *Phil. Mag.* 14. *pp.* 270–275, *Aug.*, 1932.—Arc spectra are obtained by thermions impinging on an anode of the material in vacuo, so that the lines are very sharp. The spectra were observed with a Lummer-Gehrcke plate. Twelve lead lines and five tin lines were examined. Ten of the lead lines and all the tin lines examined were simple. The two metals were chosen because of their complexity in isotopes. A. C. M.

1042. Hyperfine Structure of Arc Lines in Vacuum of Bismuth in the Visible and Ultra-Violet Regions. W. Mohammad and P. N. Sharma. *Phil. Mag.* 14. *pp.* 977–990, *Nov.*, 1932. *Supplement.*—The hyperfine structures of thirteen lines of bismuth in the visible and ultra-violet regions are measured and the results compared with those of other authors. It is found necessary to use two Lummer plates of different

resolving power in order to determine the exact wave-lengths of the components of a line. It is concluded that, in order to analyse the more complex types of hyperfine structure without ambiguity, the method of crossed spectra must be used either with two Lummer plates or with one plate and another interference apparatus. J. E. K.

1043. Hyperfine Structure of Arc Lines in Vacuum of Bismuth in the Visible and Ultra-Violet Regions. Part II. W. Mohammad and P. N. Sharma. *Phil. Mag.* 14. *pp.* 1143–1149, *Dec.*, 1932.—The term-schemes of various levels of bismuth have been worked out from the measurements of the hyperfine structure communicated in Part I of this paper [see Abstract 1628 (1932)]. The term separations so obtained agree fairly well with the measurements of Goudsmit and Back. J. E. K.

1044. Hyperfine Structure of the Spectra of Sodium, Mercury and Lead. Origin of the Intensity Variation of Hyperfine Structure Components. K. Murakawa. *Inst. Phys. & Chem. Research, Sci. Papers, No.* 398. *pp.* 1–12, *Dec.*, 1932. *In English.*—Measurement of the intensity ratio of the components of the line λ 5889·96 ($3^2S_{1/2} - 3^2P_{3/2}$) of sodium shows that sodium has the nuclear moment 1/2, a value which differs from that obtained from band spectroscopy. Some further measurements of the hyperfine structure of mercury and lead lines are made. It is shown that uneven self-absorption of hyperfine structure components is the cause of their intensity variation. J. E. K.

1045. Hyperfine Structure and Atomic Nuclei. H. Kallmann and H. Schüler. *Ergeb d. exakt. Naturwiss.* 11. *pp.* 134–175, 1932.—A chapter consisting of a critical survey and discussion of recent experimental and theoretical investigations of the hyperfine structure of spectral lines. The scope of the article can be judged from the following subtitles: Experimental methods of hyperfine structure measurement; magnetic splitting of spectral terms; elementary theory of the interaction of two magnetic moments; intensity laws; quantitative theory of the coupling between nucleus and electron shells; experimental results; determination of hyperfine structures from the interval rule and intensity laws; comparison between experiment and the quantitative coupling-theory; questions of nuclear structure; isotope displacement effect. A list of over 100 references to the most important literature on this subject is appended. J. E. K.

1046. Dispersion and Absorption of Helium. J. P. Vinti. *Phys. Rev.* 42. *pp.* 632–640, *Dec.* 1, 1932.—A wave-mechanical investigation is made of the relative importance of singly-excited, doubly-excited, and continuous states in the dispersion and absorption spectrum of helium. It is found that the continuous states are the most important whilst the role of the singly-excited states is but moderately important and that of the doubly-excited small. The relative intensities in the principal series absorption spectrum are discussed and tabulated. A. H.

1047. Calculation of the Terms of the Optical Spectrum of an Atom with one Series Electron. J. McDougall. *Roy. Soc., Proc.* 138. *pp.* 550–579, *Dec.* 1, 1932.—Hartree's method of self-consistent fields, which gives good energy values for the X-ray levels, but not for the optical terms, effectively assumes the wave function Ψ of an atom to be a simple product of the wave functions of a single electron in a central

field. Following Slater, the author adopts for the wave function Ψ', a determinantal form which is the sum of the expressions obtained by permuting the co-ordinates of the different electrons in the simple product of one-electron wave functions. This form of Ψ' must be assumed in order to satisfy Pauli's exclusion principle and be antisymmetric in the co-ordinates of all pairs of electrons. The energy values are obtained as the diagonal terms of the energy matrix $\Psi'H\Psi'$ where H is the energy operator. Expressions are obtained for the energy differences corresponding to optical terms, which represent the Hartree values plus corrections due to the interaction between the series electron and the core. The numerical calculations made for the optical terms of Si^{+3} show much closer agreement with the experimental values than do Hartree's results. This work makes it clear that a polarisation effect is not the cause of Hartree's discrepancies. W. S. S.

1048. Widening and Shift of Spectral Lines with Pressure. M. Kulp. *Zeits. f. Physik*, 79. 7–8. *pp.* 495–510, *Dec.* 3, 1932.—The effect of neighbouring atoms and molecules on the width and shift of absorption and emission lines is calculated. An expression is given which shows that the shift is proportional to the density of the gas molecule. Widening is proportional to decrease of density, which has a different value at each point of the gas at the moment the act of absorption or emission occurs. Expressions are given for symmetrical and unsymmetrical widening. Special cases, such as multiplets, are also considered. F. S.

1049. Band System of CaO in the Near Infra-Red. P. H. Brodersen. *Zeits. f. Physik*, 79. 9–10. *pp.* 613–625, *Dec.* 15, 1932.—It is established that the oxide of calcium is the carrier of a band system which appears in the near infra-red of the spectrum of calcium compounds. 20 band heads of this spectrum are measured and fitted into a scheme according to their vibrational quantum numbers. The formula for the position of the band-heads is derived. The rotation structure of the (0—0), (1—1) and (1—4) bands is analysed and the moment of inertia and the nuclear separation for the upper term are calculated, these are $62{\cdot}3 \times 10^{-40}$ and $1{\cdot}82 \times 10^{-8}$ respectively. For the lower term $I'' = 5{\cdot}2 \times 10^{-40}$ and $\tau'' = 1{\cdot}74 \times 16^{-8}$ cm. The electron terms are both $^1\Sigma$. J. E. K.

1050. Band Spectrum, Predissociation and Structure of the P_2 Molecule. G. Herzberg. *Ann. d. Physik*, 15. 6. *pp.* 677–706, *Dec.*, 1932.—The band spectrum has been investigated with quartz and vacuum grating spectrographs and the rotation-structure of some bands analysed. From the position of predissociation, an upper limit to the heat of dissociation has been fixed at 5·008 volts or 115·45 k. cal. The structure of the molecule is discussed according to the Fermi-Dirac Theory. F. S.

1051. Spectra Emitted during the Early Stages of a Condensed Discharge through Nitrogen at Low Pressure. H. Hamada. *Tohoku Univ., Sci. Reports*, 21. *pp.* 549–553, *Dec.*, 1932. *In English.*—The spectra emitted during the early stages of a condensed discharge through nitrogen at low pressure are observed, and it is confirmed that the second positive bands as well as the negative bands begin to be emitted after an interval of time of $0{\cdot}4 \times 10^{-8}$ second, and during an interval

of $1 \cdot 7 \times 10^{-8}$ sec., from the beginning of the discharge, and also that the first positive bands are emitted mainly after an interval of more than 7×10^{-7} sec. from the beginning of the discharge, while the active nitrogen lasting after each discharge is absolutely destroyed by its own discharge. The measurements are made by means of a Kerr-cell electro-optical shutter. The mechanism of the activating processes is discussed. J. E. K.

1052. Infra-Red Absorption Spectra of Hydrocarbons. P. Lambert and J. Lecomte. *Ann. de Physique*, 18, *pp.* 329–390, *Nov.*, 1932.—A self-registering spectrometer has been constructed and its outstanding advantages and manipulation are discussed. Its spectral range is 6–16μ. By it the spectra of 16 aliphatic hydrocarbons, some saturated and some unsaturated, were recorded. Spectra of 40 cyclic hydrocarbons derived from benzene, cyclohexane, cyclohexene, napthalene, diphenyl, anthracene and phenanthrene have also been obtained. The experimental method employed is one in which very small quantities of the substance need be used. In most cases investigations were carried out with liquid substances, but carbon disulphide was employed as solvent for the diphenyl derivatives. The ascertained spectra are all individually characteristic and it is suggested that the investigation of the infra-red spectra of hydrocarbons could be employed for distinguishing individual members of the same homologous series and identifying isomers of cyclic hydrocarbons, for classifying in the correct series hydrocarbons produced, for example, as intermediate products in a synthesis, and for estimating the purity of an unknown hydrocarbon. Observed data are compared briefly with the data from Raman spectra wherever available. W. R. A.

1053. Infra-Red OH band of Phenol. M. Naherniac. *Comptes Rendus*, 195. *pp.* 1254–1255, *Dec.* 19, 1932.—The absorption band of phenol in the neighbourhood of 9700Å was studied by means of a Freymann photoconducting cell. When fused in the pure state, phenol has a wide infra-red band, which on further heating is displaced towards the shorter wave-lengths, with a maximum shifting from 9853 to 9776Å. Dissolved in CCl_4 the substance shows a band with two maxima: 9892 and 9728. The former disappears on diluting the solution to 10%, whereas the latter is displaced towards the shorter wave-lengths and becomes more intense. Heating produces somewhat similar effects. Dissolved in benzene, the same two bands appear, but they do not change their relative intensities on diluting. E. E. F.d'A.

1054. Infra-Red Absorption Spectrum and Molecular Spectrum of Ozone. S. L. Gerhard. *Phys. Rev.* 42. *pp.* 622–631, *Dec.* 1, 1932.—The envelopes of four of the infra-red absorption bands of ozone ($4 \cdot 7\mu$, $7 \cdot 39\mu$, $9 \cdot 6\mu$ and $11 \cdot 38\mu$) have been mapped out with a grating spectrometer. Whilst the rotational structure is not completely resolved it appears to possess the irregularity characteristic of an asymmetrical rotator. The fundamental frequencies appear to be 528 cm^{-1}, 1033 cm^{-1} and 1355 cm^{-1}. The form of the molecule is discussed and it is shown that it cannot be a straight line or an equilateral triangle but that probably it is an isosceles triangle with the angle at the apex less than 60°. A. H.

1055. Absorption Measurements and Transition Probabilities for the A (0,0) and B (0,1) Bands of Oxygen. W. H. J. Childs. *Phil. Mag.* 14. *pp.* 1049–1060, *Dec.*, 1932.—Total absorption measurements are made on the atmospheric A- and B-bands (due to oxygen) the

sun being approximately 9° above the horizon. The relative intensities of the bands give directly the ratio of the probabilities (p) of the vibration quantum number transitions, and in this case it is found that $p_{00} : p_{01} = 0{\cdot}081$. Assuming that the whole width of these lines is due to impact broadening, it is possible to calculate the total absorption for any thickness of gas. This is done for the atmosphere; the calculated values are in excellent agreement with observation. Two consequences of impact broadening are (a) the half-width of a line is proportional to the square root of the number of absorbing molecules; (b) the total absorption is also proportional to the square-root of the number of absorbing molecules. These measurements enable conclusion (b) to be tested; it is found to be completely verified by both bands. A. H.

1056. Infra-Red Absorption Spectra of Ammonium Salts in the Region of their Anomalous Specific Heats. R. Pohlman. *Zeits. f. Physik*, 79. 5-6. *pp.* 394–420, *Nov.* 26, 1932.—Using a sublimation method it was possible to prepare thin layers of easily decomposed, hygroscopic ammonium salts. Changes in the surface of such crystal layers through changes in temperature have been studied thoroughly and are explained by the increase in the number of micro-crystals. The spectra of the chloride, bromide, sulphate, and nitrate have been examined between $2{\cdot}5$ and 9μ at room temperature and at −80°C. Isochromates for the salts have been plotted and show the instability of the ammonium radical, especially at temperatures corresponding with those calculated from specific heat measurements. The results on ammonium sulphate indicate the instability of the sulphate radical also. The nature of the anion has an important influence on the result. W. R. A.

1057. Ultra-Violet Absorption of Halogen Derivatives of Methane. A. Henrici. *Zeits. f. Physik*, 77. 1–2. *pp.* 35–51, *July* 19, 1932.—Continuous radiation from a hydrogen tube was led at one end through the substance examined to a quartz spectrograph, and at the other end through the substance examined to a fluorite vacuum spectrograph, so that absorptions could be observed from 1520 to 6000Å. All the halogen derivatives of CH_4 were investigated, except CI_4 and the fluorides. Methyl iodide gave a series of sharp bands which could be arranged into series. Term schemes are given for CH_3I, CH_3Br, CH_3Cl and CH_2I_2, and vibrational levels are involved whose values are similar to those found for the appropriate substances in the Raman effect and infra-red absorption. A. C. M.

1058. Absorption of Ultra-Violet Radiation by Methane, Ethane and Normal Butane in the Gaseous State. W. Kemula and S. Mrazek. *Comptes Rendus*, 195. *pp.* 1004–1005, *Nov.* 28, 1932.—Pure methane, ethane and n-butane do not exhibit any appreciable absorption between the wave-lengths 6000Å and 1965Å. Butane prepared by Grignard's method from butyl iodide contains about 4% by volume of an unidentified compound which exhibits 15 well-defined absorption bands between 2206 and 1965Å; none of the probable reaction products show similar absorption. H. F. G.

1059. Ultra-Violet Absorption Spectra of Phosphine, Arsine, and Stibine. G. H. Cheesman and H. J. Emeléus. *Chem. Soc., J. pp.* 2847–2848, *Dec.*, 1932.—The absorption spectra of PH_3, AsH_3 and SbH_3 are photographed by means of a small quartz spectrograph with a

Wood's hydrogen tube used as a source. With PH_3 two diffuse bands at 2315A and 2290A are observed whilst continuous absorption starts slightly below these wave-lengths. In the case of the other two gases no bands are observed but continuous absorption is observed in the same region as before. The dissociation energies of the three compounds are discussed. A. H.

1060. Rotation-Vibration Spectrum of Acetylene. W. Lochte-Holtgreven and E. Eastwood. *Zeits f. Physik*, 79. 7–8. *pp.* 450–454, *Dec.* 3, 1932.—The authors give a new allocation of the observed rotation-vibration bands of acetylene. The possibility of the appearance of a Q branch is discussed. W. S. S.

1061. Energy of the Ground State of Methane. H. J. Woods. *Faraday Soc., Trans.* 28. *pp.* 877–885, *Dec.*, 1932.—A mathematical determination of the energy of the ground state of methane on the assumption that the bonds are of the " electron-pair " type. The values obtained for the energy of the C — H bond and for the C — H distance agree well with those obtained experimentally. A. H.

1062. Quantum Theory of Spontaneous Disintegration of Diatomic Molecules. G. Müller. *Zeits. f. Physik*, 79. 9–10. *pp.* 595–600, *Dec.* 15, 1932.—An expression is derived, through a solution of Schrödinger's equation, for the breadth of the lines in the spectrum of a diatomic molecule due to the rotational disintegration of the molecule. The values obtained differ by a factor of 4 from the previous estimates of Kronig [see Abstract 3452 (1930)] and are in good agreement with Rydberg's measurements on the HgH spectrum. G. G. S.

1063. Rotational Uncoupling, with application to the Singlet Hydrogen Bands. P. M. Davidson. *Roy. Soc., Proc.* 138. *pp.* 580–593, *Dec.* 1, 1932.—Some points in the theory of rotational uncoupling are discussed, and it is applied to the nd^1 bands of hydrogen. The levels themselves and the intensities in the bands are found to agree fairly well with the theory. AUTHOR.

1064. Spectra of Chromium in Crystals. O. Deutschbein. *Phys. Zeits.* 33. *pp.* 874–877, *Nov.* 15, 1932.—Chromium phosphors give line spectra which are more easily interpreted than those of the rare earths or uranyl salts because of the simpler and better known electron arrangement. The investigation of a large number of Cr phosphors has shown that Cr can only become an activator when it enters a lattice isomorphically as CrO or a more complicated molecule. A number of examples are given together with diagrams showing the spectra. It is pointed out that Cr alum and Cr salts in solution show similarities to the luminescent spectra in absorption, from which it is assumed that Cr^{+++} is the responsible agent. Further, the analysis of the Cr^{+++} spark spectrum discloses terms which account for the principal lines in the luminescent spectra. Diagrams are given showing this. Since the frequency differences obtained from the bands in the luminescent spectra agree with the Raman frequencies for the crystals, it is considered that the former spectra are due to the superposition of the lattice vibrations on the electron transitions. J. E.

1065. Resonance Spectrum of Hydrogen. K. R. Rao and J. S. Badami. *Roy. Soc., Proc.* 138. *pp.* 540–549, *Dec.* 1, 1932.—In the course

of experiments on the spectrum of arsenic with the Paschen hollow kathode discharge, photographs have been obtained showing the Lyman series of hydrogen very strongly developed; the series is traceable down to the fifteenth member. The peculiar feature has been noticed that the intensity, instead of diminishing with successive members as in the case of a normal series, is enhanced markedly at the tenth and the eleventh members, and then falls off abruptly, indicating the occurrence of a kind of resonance phenomenon. Further experiments have shown that this anomalous feature disappears in the absence of arsenic in the discharge tube but appears more markedly with increasing pressure of arsenic vapour. The explanation is suggested that the phenomenon is caused by a transfer of energy by collisions of the second kind between the arsenic atoms in the metastable state $4p^2\,{}^1S_0$ of AsII and the atoms of hydrogen. This explanation is supported by the equality of the excitation energies involved. A new type of impact is thus demonstrated in the occurrence of this phenomenon, for the energies of ionisation and excitation of one atom are simultaneously transferred to another atom by a single act of collision. AUTHORS.

1066. Zeeman Effect of Forbidden Dipole-lines. C. J. Bakker and E. Segrè. *Zeits. f. Physik*, 79. 9–10. *pp.* 655–660, *Dec.* 15, 1932.—The behaviour of the forbidden line of mercury 3680 ($6\,{}^3P_2 - 7\,{}^3P_2$) in a magnetic field is investigated. The theory of the forbidden dipole-radiation in an electric field is experimentally confirmed. F. S.

1067. Raman and Infra-Red Spectra of CO_2. A. Langseth and J. R. Nielsen. *Zeits. f. phys. Chem.* 19. *Abt. B.* 1. *pp.* 35–46, *Sept.*, 1932.—The Raman spectrum of CO_2 at 30 atmospheres pressure has been observed with a high dispersion thermostatically-controlled spectrograph with an exposure of 14 days. In addition to the four well-known lines recorded by others, several weak lines have been found. The present paper is a preliminary report, in which an interpretation of the spectrum is given in terms of Fermi's theory. Mecke [see Abstract 3138 (1932)] has identified the strong lines $1388{\cdot}9$ and $1285{\cdot}8$ cm^{-1} as $2\nu_2$ and ν_1 respectively. These are of the same order of intensity, and the overtone $2\nu_2$ should be very much weaker than ν_1. ν_1 should be perfectly polarised, while $2\nu_2$ should have a depolarisation 6/7. The depolarisation of the two lines is observed to be approximately the same. Fermi [see Abstract 455 (1932)] has shown that two strong lines appear because of a degeneracy introduced since $2\nu_2$ is approximately equal to ν_1. Numerous weak lines observed by the authors are interpreted by extending Fermi's theory, and a partial energy diagram is given which accounts for six Raman and thirteen infra-red lines. A. C. M.

1068. Raman Spectrum of Carbon Dioxide. A. Langseth and J. R. Nielsen. *Zeits. f. phys. Chem.* 19. *Abt. B.* 6. *pp.* 427–433, *Dec.*, 1932.—The authors have extended a recent study of the Raman spectrum of carbon dioxide [see preceding Abstract] and have examined the spectrum of the gas at 30 atmospheres pressure. Besides the four already known Raman lines, six more have been found. All the new lines are extremely weak. Taking these results in conjunction with the recent infra-red absorption measurements of Martin and Barker [see Abstract 4972 (1932)] the newly-recorded Raman lines are characterised as the maxima of P and R rotational branches. The respective transitions are given in Dennison's quantum numbers. W. R. A.

1069. Raman Effect of Certain Inorganic Halides in the Liquid and Gaseous States. H. Braune and G. Engelbrecht. *Zeits. f. phys. Chem.* 19. *Abt.B.* 5. *pp.* 303–313, *Dec.*, 1932.—Investigation of the Raman spectra of molten and vaporised mercury halides shows that, in the state of vapour, the frequency of the inactive vibration is proportional, within the limits of experimental accuracy, to the heat of dissociation. With the molten and dissolved salts, however, systematic deviations appear. The difference between the frequencies in the gaseous and fused states increases with the degree of polarity of the linking; this behaviour is shown also by the results obtained with the trihalides of phosphorus, arsenic and antimony. T. H. P.

1070. Calculation of the Characteristic Vibrations of Organic Chain-Molecule Models. E. Bartholomé and E. Teller. *Zeits. f. phys. Chem.* 19. *Abt.B.* 5. *pp.* 366–388, *Dec.*, 1932.—The characteristic vibrations of much-simplified models of hydrocarbons and some hydrocarbon derivatives are discussed. On the assumed model only the frequencies of the so-called valency vibrations differ from zero. These lie between an upper and a lower limit which lie closer to one another the less the valency angle deviates from 90°. If the frequency of a group which is attached to a carbon chain lies outside these limits, it will give a normal vibration in which essentially the attached group alone vibrates, and whose frequency is hardly influenced by the length of the hydrocarbon chain, since this frequency cannot be propagated in the chain. An explanation is thus given of the fact that in the Raman effect of hydrocarbon halides the halogen frequency is independent of the length of the chain. Only the fluorine frequencies, which have not as yet been systematically investigated, lie in the resonance region and must depend on the chain-length. J. E. K.

1071. Circular Polarisation of Raman Lines. Part II. W. Hanle. *Ann. d. Physik*, 15.3. *pp.* 345–360, *Nov.*, 1932.—A qualitative determination of circular polarisation gives information almost as important as quantitative determinations of linear polarisation, for if by end-on observation the Raman radiation is circularly polarised similarly to the incident radiation, the depolarisation in the linear case will be zero; if the Raman radiation is not circularly polarised, then it corresponds to a depolarisation of $\frac{1}{3}$ in the linear polarisation case; if the Raman radiation is circularly polarised oppositely to the incident radiation, then the corresponding linear depolarisation would be in excess of $\frac{1}{3}$, and more in excess, the stronger is the opposite circular polarisation of the Raman radiation. New results are given for xylene, monochlorbenzene, benzaldehyde, trichlorethane, acetylene tetrachloride, CS_2, ammonia, nitric and sulphuric acids. A table is appended giving results of Parts I and II, and attempts are made to allocate frequencies to linkages. [For Part I see Abstract 1638 (1932).] A. C. M.

1072. Raman Effect of CO. E. Amaldi. *Zeits f. Physik*, 79. 7–8. *pp.* 492–494, *Dec.*, 3, 1932.—The rotation Raman spectrum and the well-known vibration line $\Delta\nu = 2145$ cms^{-1} have been obtained with the gas at a pressure of 6 atmospheres. J. E.

1073. Raman Spectra of Dimethyl Ether, Diethyl Ether, and Heptane. S. C. Sirkar. *Indian Journ. Phys.* 7. *pp.* 257–272, *July*, 1932.—Two spectra were obtained for heptane, one with a uranine filter

and one with an ortho-cresol-phthalein filter, in order to assign the lines correctly. In the case of diethyl ether, one spectrogram was taken without a filter, and one with quinine sulphate to suppress 4046 Å as an exciting line. The dimethyl ether was examined as a liquid, using liquid air to cool it, and a long exposure without filter was given. In heptane 154 cm^{-1} observed by Bonino and Brüll and by Ganesan and Venkateswaran is not found; six other lines observed by Ganesan and Venkateswaran are not found, while 2651 and 2704 cm^{-1} are reported for the first time. In diethyl ether four lines found by other workers are not observed, while a new line at 375 cm^{-1} is reported. Comparison with Coblentz' infra-red data shows most of the lines to be active. In diethyl ether two new lines at 33 and 416 cm^{-1} are reported. Taking the three radicals as masses of 16, 15 and 15 units each, a rough fit is obtained as an isosceles triangle of vertical angle 53° 42′. A. C. M.

1074. Polarisation of Light-Scattering. S. Venkateswaran. *Phil. Mag.* 14. *pp.* 258–270, *Aug.*, 1932.—Light scattered at right angles by liquid in a large bulb was analysed by a spectrograph, using a large nicol first in one orientation and then in a perpendicular one. The time of exposure in the two cases was adjusted so as to give equal density of blackening in the two cases. The sources of error are discussed. The depolarisations observed for unmodified lines are tabulated for benzene, carbon disulphide, toluene, carbon tetrachloride and phosphorus trichloride both for a wide and a narrow slit. The values calculated using the spin-theory agree closely, while those calculated from classical theory do not. A discussion of the spin-theory is given. A. C. M.

1075. Ions of Type $M(OH)_n^{x+}$ in the Raman Effect. Z. Ollano. *N. Cimento*, 9. *pp.* 264–269, *Aug., Sept., Oct.*, 1932.—Ions of the type $M(OH)_n^{x+}$, where M is the metallic radical, x the valency and $n = 1, 2, 3 \ldots$, are present in hydrolysed salts. The present paper deals with the case of bismuth nitrate in various concentrations, and the lines found in the Raman spectrum, using a mercury arc, are tabulated. The characteristic frequency shifts for OH^- and NO_3^- are found, and also lines attributed to $Bi(OH)^{++}$ and $Bi(OH)_2^+$. J. H. A.

1076. Raman Spectra of Naphthalene Derivatives. S. Ziemecki. *Zeits. f. Physik*, 78. 1–2. *pp.* 123–132, *Sept.* 8, 1932.—The Raman spectra of naphthalene, α- and β- methyl-naphthalene, α- and β chlornaphthalene, and α- brom-naphthalene were measured in the molten condition. The frequency 1377 cm^{-1} is common to all these substances; the frequencies 3058 and 1575 cm^{-1} also are common, but with greater fluctuation in the exact values. The strongest lines of the β compounds occur also in the corresponding α compounds. A. C. M.

1077. Molecular Scattering of Light from Ammonia Solutions. Fine Structure of a Vibrational Raman Band. J. W. Williams and A. Hollaender. *Phys. Rev.* 42. *pp.* 379–385, *Nov.* 1, 1932.—The Raman band of the ammonia molecule corresponding to the infra-red absorption at 3 μ has been partially resolved into its fine structure. The experiments have been made not with gaseous or liquid ammonia but with aqueous solutions of relatively high concentration. The lines have been assigned to Q, P, R, PP, and RR branches, corresponding to changes in rotational quantum number $\Delta k = 0, \pm 1$, and ± 2. The moment of inertia about a line normal to the axis of symmetry calculated from

the spacing of the lines is $I = 2 \cdot 82 \times 10^{-40}$ gm. cm^2. As far as the present, somewhat incomplete results may be taken to indicate the structure of the NH_3 molecule is largely uninfluenced by the force fields of the solvent molecules. AUTHORS.

1078. Raman Spectra of a Series of Normal Alcohols and Other Compounds. R. W. Wood and G. Collins. *Phys. Rev.* 42. *pp.* 386–392, *Nov.* 1, 1932.—The Raman spectra of benzene, cyclohexane, cyclohexene, $C{\cdot}S_2$ butyl bromide and the normal alcohols from CH_3OH to $C_{12}H_{25}OH$ were investigated. The technique recently developed by Wood [see Abstract 1998 (1932)] was used in conjunction with a praseodymium filter. New lines were found in all cases and for some compounds the number was nearly doubled. Two new frequencies at 2660 and 2730 cm^{-1} were found in the spectra of essentially all the alcohols and butyl bromide. They appear to be characteristic of the saturated hydrocarbons. The lines which appear in the Raman spectra of the aliphatic hydrocarbons at 1450 and 1300 cm^{-1} have been attributed respectively to the transverse vibrations of the hydrogens of the CH_3 and CH_2 groups. The line appearing in the Raman spectra of the alcohols at 1270 cm^{-1} is attributed to the transverse vibrations of the hydrogens of the CH_2OH groups. It is pointed out that the Raman spectra of $C_{12}H_{25}OH$ is that of an infinitely long normal alcohol. The new lines of benzene reported by Weiler and Krishnamurti were verified with the exception of the 806 cm^{-1} frequency. In addition a new line at 1690 cm^{-1} was found. The two relatively strong lines of CS_2 at 650 and 800 cm^{-1} were each found to be doublet, thus completing the analogy with CO_2. The separation of the components in each case was 10 cm^{-1}. The existence of a line at 391 cm^{-1}, originally reported by Bhagavantam, was verified. AUTHORS.

1079. Raman Effect of Molecular Types XY_6 and XY_5. O. Redlich, T. Kurz, and P. Rosenfeld. *Zeits. f. phys. Chem.* 19. *Abt.B.* 4. *pp.* 231–241, *Nov.*, 1932.—The substances investigated were placed in a cone-shaped flask surrounded by a cone-shaped water jacket and illuminated by a mercury-vapour lamp. The exposure time was 30 hours, and an apparatus is described whereby the necessity of continual supervision throughout the whole exposure was eliminated. Raman spectra of $HSbCl_6$, H_2SnCl_6, Li_2SnCl_6, $MgSnCl_6$, and $SbCl_5$ have been obtained, and the ascertained displacements are tabulated. Only very diffuse lines could be obtained from Na_2SnCl_6; whilst no displacements were observed for H_2PbCl_6 or H_2SiF_6. The observed displacements can be arranged according to Placzek's selection rules on the assumption of a molecular model with central forces. The valency force model cannot be used to explain the observed data. W. R. A.

1080. Molecular Symmetry and Diffusion Spectra. J. Cabannes. *Ann. de Physique*, 18. *pp.* 285–327, *Nov.*, 1932.—An elementary theory of rules of selection and polarisation of Raman lines is deduced from the notion of molecular anisotropy. These rules are applied to molecules which have elements of symmetry. When the diffusion lines and their depolarisation have been found, these rules permit a choice of molecular model and allows the symmetry to be determined. The theory is compared with the results of Mannebeck and Placzek, and further examples are to be given by Rousset [see following Abstract]. Most of the rules have already been given by Brester and Placzek, but not in such an elementary form. F. S.

1081. Molecular Diffusion of Light. A. Rousset. *J. de Physique et le Radium*, 3. *pp.* 555–564, *Nov.*, 1932.—The continuous spectrum accompanying molecular diffusion in liquids is attributed to the molecular field. Rocard has deduced formulæ for the intensity and state of polarisation. The extent of the spectrum and dissymmetry with regard to the exciting line are also explained. These theoretical views are here verified for benzene, acetic acid, carbon tetrachloride and ethyl alcohol. F. S.

1082. Raman Band in Water. G. Bolla. *N. Cimento*, 9. *pp.* 290–298, *Nov.*, 1932.—Studies the form of the Raman band excited in water at 17°C. by the mercury line 2537 Å, photographed with two cameras, one of high dispersion. Finds three components corresponding to the following: $\Delta\nu$: 3650, feeble; 3435 cm.$^{-1}$, strong; and 3200 cm.$^{-1}$, medium. Examines the form of the line 2537 Å and measures bands at $\pm$ 172 cm.$^{-1}$ and $\pm$ 60 cm.$^{-1}$ respectively. E. E. F. d'A.

1083. Influence of Ions on the Raman Bands of Water. N. Embirikos. *Phys. Zeits.* 33. *pp.* 946–947, *Dec.* 1, 1932.—The work of Gerlach [see Abstract 4025 (1930)] has been repeated and extended. The previous results for univalent chlorides are confirmed; the intensity of the short wave-length side of the double water band decreases with increase of concentration, becoming very small in normal solutions. The lines excited by 4047 and 4358 Å radiation do not exhibit structure, even with a dispersion of 25 Å per mm.; at high concentrations their breadth is about 70 cm.$^{-1}$. The kation appears to exert no influence on the Raman bands of water. Similar results are obtained with divalent chlorides. Univalent nitrates cause with increasing concentration an increasing distance between the components of the band; with $5 - 8$ *N* ammonium nitrate solution the distance is 320 $\pm$ 25 cm.$^{-1}$, as compared with 210^{-} cm.$^{-1}$ for water. The change is due mainly to displacement of the shorter wave-length component. Divalent nitrates produce a similar change. H. F. G.

1084. Existence of a Continuous Raman Effect in Liquids. R. Bär. *Zeits. f. Physik*, 79. 7–8. *pp.* 455–470, *Dec.* 3, 1932.—With a view to deciding whether or not the continuous background frequently observed with Raman spectra is due to a Raman effect, the spectra of various liquids, including benzene, glycerin, sulphuric acid, potassium hydroxide solution, formic acid, and certain binary mixtures, have been studied, using circularly polarised incident light. In all cases the continuous spectrum is due to fluorescence or to a Rayleigh scattering of the continuous background of the radiation from the mercury arc lamp used. The theoretical relation between the depolarisation (with perpendicular observation) and the degree of reversal of the circular polarisation (with parallel observation) is confirmed. H. F. G.

1085. Raman Effect in Organic Nitrates. A. S. Ganesan and V. N. Thatte. *Phil. Mag.* 14. *pp.* 1070–1080, *Dec.*, 1932.—Six organic nitrates have been studied, and also solutions of two of them (methyl nitrate in methyl alcohol and iso-amyl nitrate in iso-amyl alcohol). The light source was a quartz-mercury-vapour lamp, the spectral region examined being approximately from 4100 to 5000 Å, and only the modified lines excited by the mercury line 4358·3 Å are discussed. Three groups of frequency shift are noted, due respectively to the C — H linkage, the C = O linkage, and the nitrate group. The latter do not agree entirely with the calculated normal modes of the NO_3 ion. J. H. A

1086. Overtone $\Delta\nu = 1539$ in the Raman Spectrum of CCl_4. L. S. Ornstein and J. J. Went. *K. Akad. Amsterdam, Proc.* 35. 8. *pp.* 1024–1026, 1932. *In German.*—Experiments are described on the intensity relationships of the tone-overtone and the breadth of the overtone with respect to the tone, in particular with respect to $\Delta\nu = 773$ and $\Delta\nu = 1539$ cm.$^{-1}$ (for the excited line 4358). H. H. Ho.

1087. Raman Spectrum of SO_4'' in Gypsum. J. Cabannes. *Comptes Rendus*, 195. *pp.* 1353–1355, *Dec.* 27, 1932.—Of the six lines in this spectrum due to internal oscillation of the ion SO_4'', 1009, 414 and 495 (cm.$^{-1}$) are symmetrical, and 671 antisymmetrical; 620 and 1136 appear to be compound in accordance with theory which requires that 620 should consist of one symmetrical and one antisymmetrical line, and 1136 of one symmetrical and two antisymmetrical lines. SO_4'' forms a nearly regular tetrahedron, the actual symmetry being probably D_2, though C_2^v or C_2 is possible. [See also Abstract 4330 (1932).] C. A. S.

1088. Investigations in the Infra-Red Region of the Spectrum. Part VII. Infra-Red Grating Spectrometer as a Double Monochromator. A. B. D. Cassie and C. R. Bailey. *Roy. Soc., Proc.* 138. *pp.* 531–539, *Dec.* 1, 1932.—The authors have previously described an infra-red monochromator arrangement [see Abstract 3805 (1931)]. In the new lay-out radiation from a Nernst filament passes through a slit and diverges to a collimating mirror where it is reflected to an 18° rock salt prism (platinum sputtered on the back surface) mounted on a theodolite circle. After reflection at the prism it passes through a second slit, is collimated, and falls on an echelette grating (3600 lines per inch) mounted on another theodolite circle readable to 1 second of arc. The beam is then focussed on a third slit from which it diverges and by means of a suitable optical arrangement, is made to pass through the absorption tubes and on to the thermopiles. The spectrometer is enclosed entirely in an approximately airtight steel case through which dry air, free from carbon dioxide, can be passed. Fitted to the grating table is a micrometer screw and a graduated drum which can be rotated from a distance, and drum graduations can be read by a telescope. The whole apparatus is arranged in such a way that it can be manipulated by one person. Necessary adjustments, experimental procedure, and sources of error are discussed. The magnitude of these errors and the resolving power of the instrument have been calculated. W. R. A.

1089. Quadripole Radiation. A. Rubinowicz and J. Blaton. *Ergeb. d. Exakt. Naturwiss.* 11. *pp.* 176–218, 1932.—Consists of a critical survey and discussion of recent experimental and theoretical researches concerning quadripole radiation. The following sub-titles indicate the scope of this article: Classical theory: The discovery of dipole radiation; Quadripole radiation and magnetic dipole radiation; Zeeman effect of quadripole lines; Intensities. Older Quantum theory: Notation of spectral terms; Correspondence principle and selection rules; Metastable states; Natural line-width. Quantum mechanics: Zeeman effect of quadripole lines according to the quantum mechanics; Normal quadripole multiplets; Intercombination lines; Absolute intensities and transition probabilities; Forced dipole radiation; Dispersion formula, f- sum-rule. A list of references to the most important recent literature is appended. J. E. K.

See also Abstracts 819, 949, 950, 1003, 1012, 1155, 1212.

VISION.

1090. Photoelectric Visibility Measurements. Part II. L. W. Pollak and W. Gerlich. *Gerlands Beitr. z. Geophys.* 37. 2–3. *pp.* 271–295, 1932.—Following up previous experiments for obtaining a sensitive photoelectric apparatus for measuring visibility [see Abstract 1924 (1932)], the temperature coefficient of the photoelectric elements is measured accurately by using a thermostat, and is found to be constant. Two d.c. amplifiers, which give amplifi ation from 100,000 to 1,000,000 for photoelectric current, are made independent of the valve characteristic. This apparatus is used to examine photoelectrically an old and new Wigand visibility-meter and an original Goldberg wedge. H. M. B.

1091. Observation with the Eye of a Schrot Effect for Photons. R. B. Barnes and M. Czerny. *Zeits. f. Physik*, 79. 7–8. *pp.* 436–449, *Dec.* 3, 1932.—The authors describe experiments in which a subject with his eye dark adapted observes 50 precisely similar weak point sources of light, with a view to detecting fluctuations in their brightnesses due to statistical variations in the number of photons per second received by the eye from each point source. The results were indefinite, but the authors believe them to indicate a positive effect. Other experiments in which half the point sources were reduced in intensity by a given proportion, were directed to discovering what differences of brightness the eye can detect. Comparison of the latter with the expected statistical fluctuations suggests that in the most sensitive condition of the eye a Schrot effect for photons may be just perceptible. W. S. S.

1092. Accommodation, Pupillary Width and Stimulus Distance. E. Freeman. *J.O.S.A.* 22. *pp.* 729–734, *Dec.*, 1932.—Continuing previous work [see Abstract 3692 (1932)] the author now finds that even when lenses are placed at the observing eye to bring the distant and near acuity objects to the same apparent position so that the accommodation of the eye is the same in both cases, the anomaly that the acuity for the distant object is greater than that for the near object still persists. Also, using a 1mm. diameter artificial pupil does not eliminate the effect. These experiments were made with the dark-adapted eye and with background brightnesses ranging from about 0·0003 to 0·001 millilamberts. The author concludes that the anomaly is not a dioptrical artifact dependent upon differences in accommodation and pupillary width. No suggestion as to the possible mode origin of the effect is put forward. W. S. S.

1093. Corresponding Retinal Points, the Horopter and Size and Shape of Ocular Images. Part II. A. Ames, Jr., K. N. Ogle and G. H. Gliddon. *J.O.S.A.* 22. *pp.* 575–631, *Nov.*, 1932.—This paper gives the experimental findings obtained with the apparatus and methods described in Part I [see Abstract 262 (1933)]. The results fall under the following headings: determinations by the criterion of the apparent frontal plane and by the criterion of constancy of visual direction, preliminary measurements on monocular relative directional values and the horopter, nature of the change of projections of corresponding retinal points with fixation distance, with asymmetrical convergence or as produced by ophthalmic lenses. W. S. S.

1094. Analytical Treatment of the Longitudinal Horopter; Its Measurement and Application to Related Phenomena, Especially to the Relative Size and Shape of the Ocular Images. K. N. Ogle. *J.O.S.A.* 22. *pp.* 665–728, *Dec.*, 1932.—Gives the mathe-

matics involved in the experimental determination, interpretation and application of the longitudinal horopter. [See also Abstract 262 (1933).] W. S. S.

1095. Modified Broca Pupillometer. F. K. Moss. *J.O.S.A.* 22. *pp.* 735–750, *Dec.*, 1932.—The instrument is a small mechanism, attached to spectacle frames, which illuminates the eye from two pin-points of light, whose distance apart is varied by a graduated lead screw. The points of light are at a distance of 6·6 cm. from the eye and cast on the retina two circular discs of light which are made tangential in taking a measurement. The instrument is calibrated for a fixation distance of 1 metre and reads directly in millimetres. A modified form in which the light from the pin-points is reflected into the eye by a 45° plate glass mirror eliminates the blocking out of a portion of the visual field (17° × 6°) by the instrument. W. S. S.

X-RAYS.

1096. Scattering of X-Rays by Gases and Crystals. G. E. M. Jauncey. *Phys. Rev.* 42. *pp.* 453–463, *Nov.* 15, 1932.—Recent formulæ for the separation of the diffusely scattered radiation from polyatomic gases and simple crystals into coherent and incoherent radiation are discussed [see Abstract 4354 (1932)]. It is shown that the coherent scattered radiation depends upon the arithmetic mean of the E's while the incoherent radiation depends upon the root mean square of the E's, thus giving a mathematical distinction between the incoherent and the coherent radiation even in the classical theory. The classical theory of the diffuse scattering of X-rays by a crystal consisting of atoms of several kinds is worked out, and a formula is obtained. G. G. S.

1097. Multiple Compton Diffusion. H. Hulubei. *Comptes Rendus*, 195. *pp.* 1249–1251, *Dec.* 19, 1932.—Multiple Compton diffusion with change of frequency is demonstrated for the first time by means of K-rays from Mo and Rh excited by 45kV 15mA, with paraffin and metallic lithium as the diffusers. The distance of the diffuser from the anti-kathode was 20 cm., and that of the photographic film 35 cm. A curved mica spectrograph was used on account of its great luminosity. The paraffin diffusers were thick prismatic blocks and the exposure varied between 6 and 35 hours. A band is found presenting a well-marked edge towards the greater wave-lengths. This is due to double diffusion with change of wave-length. Double Compton diffusion must be of importance even in ordinary light, where it enters as a depolarising factor. E. E. F. d'A.

1098. Modification of X-Rays by Passage through Matter. S. Bhargava and J. B. Mukherjee. *Acad. Sci. U.P., India, Bull.* 1. *pp.* 48–53, 1931–1932.—The phenomenon reported by B. B. Ray [see Abstract 1561 (1931)] is explained as due to the quantum of incident radiation of frequency ν, parting with energy $\not<$ sufficient to remove an electron from the K, L, or M shell, the excess over that amount appearing as kinetic energy of the expelled electron, while the quantum moves on with the balance $(h\nu - h\nu_{\text{K, L or M}} + \frac{1}{2}mv^2)$. In such circumstances the emergent beam should show bands with a sharp edge on the short wave-length side at ν-ν_{K}, ν-ν_{L}, etc. Such bands were obtained on passing Cu-Kβ radiation through carbon (black paper), and AgKα radiation through nickel. C. A. S.

1099. X-Ray Diffraction in Ethyl Ether Near the Critical Point. F. H. W. Noll. *Phys. Rev.* 42. *pp.* 336–339, *Nov.* 1, 1932.—X-ray diffraction ionisation curves were obtained for ethyl ether at $43{\cdot}5 \pm 0{\cdot}7$ kg/cm^2 pressure with temperatures in the range from 25°C to 210°C. The critical pressure and temperature of ether are $36{\cdot}7 \pm 0{\cdot}2$ kg/cm^2 and $194{\cdot}6 \pm 0{\cdot}3$°C, respectively. In the region of the higher temperatures the ionisation curves are a combination of the liquid and polyatomic gas types, falling rapidly near 0° with increasing angle, then rising to a distinct peak and again falling. Liquid semi-orderly "cybotactic" groups are in evidence from room-temperature to 199°C but not for specific volumes greater than the critical specific volume. It seems reasonable to expect vanishing of these groups at the critical point. The influence of the polyatomic gas type begins to appear at the low temperatures and increases with temperature. The liquid type decreases almost linearly until 155°C where it begins to fall off very rapidly. The observations are in excellent accord with the "cybotactic" view of the interior of a liquid. AUTHOR.

1100. Intensity Relations in the L Regions of the Rare Earths. G. v. Hevesy and E. Alexander. *Zeits. f. Physik*, 78. 9–10. *pp.* 576–579, Oct. 18, 1932.—The ratio of the intensities of the $L\alpha_1$ and $L\beta_1$ lines of the rare earths under similar primary excitation by tungsten and molybdenum rays has been determined by mixing pairs of successive elements in equal atomic ratio. The lines were photographed with a Bragg spectrograph. The results are given numerically, and are plotted as curves giving the intensity ratio of successive elements against atomic number. These curves are shown next to the one for the paramagnetism ratio of the successive elements and are seen to take a similar course, with a minimum at europium. These results are assumed to confirm the conclusion drawn from the paramagnetic results that there exists a subdivision in the rare earth group. J. E.

1101. N-Series of the Elements 73Ta – 81Tl. Part I. T. Magnusson. *Zeits. f. Physik*, 79. 3–4. *pp.* 161–169, *Nov.* 14, 1932.—N_{IV}, N_{VI} and N_{V}, $N_{VI, VII}$ lines in the X-ray spectra of 73 Ta, 74 W, 76 Os, 77 Ir, 78 Pt, 79 An and 81 Tl are determined and tabulated. The K-absorption limit of carbon was found to occur at 43·3 Å. J. S. G. T.

1102. X-Ray Spectra and Lattice Binding. R. Glocker. *Phys. Zeits.* 33. *pp.* 963–967, *Dec.* 15, 1932.—The form and breadth of the $K\alpha$ line of carbon of wave-length 44·5 Å, is discussed for the cases of graphite, diamond, and carborundum. In the case of diamond the line is split up into a doublet and for carborundum the distribution of intensity is different from that for graphite. The difference between the graphite and diamond lines is accounted for by the different types of binding in the two cases. The result for carborundum is due to the disturbing effect of the silicon atom. An analogous effect is found in the case of metallic solid solutions and the case of the Pd-Ag series is quoted as an example. J. T.

1103. Fine Structure of Kα of Carbon. M. Morand and A. Hautot. *Comptes Rendus*, 195. *pp.* 1070–1071, *Dec.* 5, and *pp.* 1383–1384, *Dec.* 27, 1932.—$K\alpha$ of carbon has been resolved first into two and finally into three lines, the two of shorter wave-length being at 0·2 and 0·7 Å from that of the longest, thus proving it to resemble $K\alpha$ of the heavier elements. [See Abstracts 2546 (1927) and 1889 (1929).] C. A. S.

1104. Measurement of X-Ray Emission Wave-Lengths by Means of the Ruled Grating. R. B. Witmer and J. M. Cork. *Phys. Rev*, 42. *pp.* 743–748, *Dec.* 15, 1932.—With a plane ruled grating measurements were made of the emission wave-lengths in the L series for the elements Va (23) to Zn (30) and in the K series for the elements C (6) to Si (14). With the exception of the $K\alpha$ lines of carbon, fluorine and oxygen, the method of the ruled grating yields a longer wave-length in every case than that found for the corresponding lines by the crystal method. The Moseley diagrams representing the observed results are found to be smooth curves. The possible variation of apparent wave-length with a variation in the grazing angle of incidence has been investigated. For angles such that the diffracted lines were not too diffuse, the computed wave-lengths were independent of the incident angle. AUTHORS.

1105. Interpretation of X-Ray Term Values. M. N. Saha and R. S. Sharma. *Acad. Sci. U.P., India, Bull*, 1. *pp.* 119–134, 1931–1932.—The authors propound a rather radically different interpretation of the X-ray term-values. The diagrammatic lines of X-ray spectra are similar to those of alkali-spectra; this has given rise to the belief that X-ray terms and their differences can be calculated in the same way as term-values in hydrogen or the alkalies, after the introduction of suitable screening constants. But the apparent analogy is rather misleading; it is due to the operation of the Pauli exclusion principle. Since the X-ray spectra are due to the removal of an electron from some level and the subsequent jumping of an electron from some outer level to this, it follows that the term-values have to be calculated in a manner widely different from that usually followed. The authors develop this thesis, giving a comprehensive survey of the questions raised, and pointing out the way to further work on calculating a theoretical expression for the ionisation-potential of atoms stripped to the Be-core, for the ionisation-potential of Ne-like atoms, and for the screening effect of outer electrons in the general case, on finding expressions for the potential inside the atom, for the negative squared terms in the screening constant, and for the doublet separations on calculating energy-values for removing two electrons out of the atoms simultaneously, and on extending the same treatment to the other X-ray levels. A. D.

1106. K-Absorption Edges of Ni, Cu, Zn, and their Compounds. M. Ishino and K. Kojima. *Kyoto Coll. Sci., Mem.*, 15. *pp.* 293–300, Sept., 1932. *In English.*—Main edge wave-lengths are tabulated for pure elements and compounds: NiO, $Ni(SO_4)_2$, CuO, Cu_2O, ZnO, ZnS (wurtzite and zinc blende), showing shortening in compounds and also with valency. Wave-length difference and energy difference are tabulated for observable fine structure in all the above; in the compounds the fine structure does not resemble that for the element; but metallic Ni and Cu resemble one another, though not Zn; nor do NiO, CuO resemble one another. The Zn edge for wurtzite appears intermediate between zincite and zinc blende. The results are regarded as supporting Kronig rather than Lindsay. T. L. M.

1107. Fine Structure in X-Ray Absorption Spectra. J. D. Hanawalt. *Frank Inst.*, J. 214. *pp.* 569–584, *Nov.*, 1932.—The paper reviews the principal experimental observations concerning the fine structure in X-ray absorption spectra and considers their explanation from the point of view of Kronig's theory. [See Abstracts 3846 (1931) and 3301 (1932).] W. E. P.

1108. X-Ray Absorption Spectra of Chlorine Compounds in Aqueous Solution. O. Stelling. *Zeits. f. phys. Chem.* 19. *Abt. B.* 6. *pp.* 462–470, *Dec.*, 1932.—A method is described for measuring the K-absorption edge of an element in solution. A rotating disc of tissue paper dips into the solution, and the liquid which is thereby absorbed is carried into the path of the X-ray beam. In order to prevent alterations in concentration from taking place the spectrograph is filled with water vapour at the saturation pressure of the solution. The results for the K-edge of chlorine obtained from NaCl solution of normal, twice normal, and four times normal strength, agree, although the wave-length is a little greater than that for solid NaCl. For solid KCl and a 1·75 normal solution of KCl the results are again in agreement with those from NaCl solutions, but for 3·3 normal the edge corresponds to a slightly shorter wave-length. J. T.

1109. Absolute Measurement of X-Ray Intensity. V. Loeck. *Ann. d. Physik*, 15. 5. *pp.* 527–544, *Dec.*, 1932.—A method of measuring the absolute intensity of an X-ray beam is described. The principle is essentially the same as that employed by Kossel and by Steenbeck [see Abstracts 2921 (1927) and 851 (1929)]. Instead of the condenser used by Steenbeck a cylindrical tube is employed with a wire down the middle. The probable error is estimated to be about 6·7% and the maximum error 15·5%. J. T.

1110. Measurement of X-Ray Intensities as Functions of Voltage, up to 180 kV. D. L. Webster, W. W. Hansen and F. B. Duveneck. *Rev. Sci. Instruments*, 3. *pp.* 729–749, *Dec.*, 1932.—The measurement of intensity of an X-ray line presents two sets of technical requirements, quite different, according to whether the intensity is to be compared with those of other lines at the same voltage or of the same line at other voltages. The latter set of requirements is discussed here, with a description of a tube designed to meet them. This tube is built of steel and pyrex, with several sections of each, permitting a variety of high-voltage connections for special purposes related to possible sources of error. To prevent the deposition of carbon and tungsten on the target, the pumping speed is made very high, especially for grease vapours. The detection of carbon, and rough measurement of its retardation of the kathode rays, is accomplished by one of the special changes of connections. To minimise the effects of such positive ions as may be present in spite of the high pumping speed, the tube has a special form of kathode. And to measure the possible amount of error due to such ions, another of the special connections transforms the kathode-ray chamber of the tube into an ionisation gauge. Finally a third change of connections makes it possible to wear out the sources of minute field currents, that would otherwise cause errors in X-ray intensity measurements. AUTHORS.

1111. Relative Intensities of the La_1, β_1, β_2, and γ_1 Lines in Tantalum, Tungsten, Iridium, and Platinum. V. J. Andrew. *Phys. Rev.* 42. *pp.* 591–608, *Dec.* 1, 1932.—The relative intensities of the La_1, β_1, β_2, and γ_1 lines in tantalum, tungsten, iridium, and platinum were measured and corrections applied for the partial absorption of the beam along its path and within the ionisation chamber, for the partial reflection by the crystal, for the effects of voltage and absorption within the target, and for interference from adjacent lines. To verify the method

of making the target correction, an experiment was performed which consisted of measuring the relative intensities of $L\alpha_1$, β_1, and γ_1 of platinum at different angles from the face of the target. The following relative intensities were measured at 30 kV. without correction for reflection by the crystal or absorption within the target:

	α_1	β_1	β_2	γ_1
Tantalum	100	49·5	18·8	9·0
Tungsten	100	49·4	20·2	10·0
Iridium	100	48·0	21·2	10·2
Platinum	100	46·1	21·0	9·7

AUTHOR.

1112. X-Ray Studies on the Hydrous Oxides. Part I. Alumina. Part II. Stannic Oxide. Part III. Stannous Oxide. H. B. Weiser and W. O. Milligan. *J. Phys. Chem.* 36. *pp.* 3010–3045, *Dec.*, 1932.—X-ray diffraction studies have been carried out on aluminas precipitated under widely varying conditions to determine what definite hydrates of alumina exist, and the evidence indicates only two, *viz.*, gibbsite, $Al_2O_3.3H_2O$, both natural and artificial, and diaspore, $Al_2O_3.H_2O$. Precipitated alumina aged at 100° is found to be a new form, termed δ-Al_2O_3, with adsorbed water. Samples prepared according to Hüttig are either δ-Al_2O_3 or a mixture of it with gibbsite, instead of a series of definite hydrates, while those of Willstätter are either δ-Al_2O_3 or amorphous Al_2O_3 with adsorbed water. The existence of Barlett's ζ-Al_2O_3 is confirmed. With stannic oxide, no definite hydrates are formed by the hydrolysis of stannic ethylates according to the method of Thiessen and Koerner, the several products consisting of stannic oxide of varying particle size with varying amounts of adsorbed water. Stannous oxide is found to exist in two polymorphic forms: α-SnO, which is blue-black in large crystals and brownish-green when powdered; and β-SnO, which is greyish-green; the transition-temperature, $\alpha \rightarrow \beta$, is 550°C. The precipitate formed by the interaction of an aqueous stannous salt with ammonia is found to be the hemihydrate, $2\,SnO.H_2O$, which is readily dehydrated into α-SnO. H. H. Ho.

1113. Self-Rectifying Demountable X-Ray Tube of High Power. C. E. Eddy. *Journ. Sci. Instruments*, 9. *pp.* 354–358, *Nov.*, 1932.—The essential requirements of a demountable X-ray tube for spectroscopy and crystal analysis are discussed, and a tube designed to satisfy these conditions is described. The tube, of the thermionic type, can be used with either a line or circular focus, and has readily detachable electrodes mounted on metal ground joints. The metal portions of the tube are either cast in one piece or assembled with welded joints in order that they may be subjected to a preliminary degassing at a high temperature. The tube is capable of passing 40 mA at 50kV for long periods, while 10 mA at 95 kV have been passed for a few minutes. Possible modifications of the tube to suit particular requirements are indicated.

AUTHOR.

1114. Filter for X-Ray Power Supply. J. B. Hoag and V. J. Andrew. *Rev. Sci. Instruments*, 3. *pp.* 750–752, *Dec.*, 1932.—A combination of a Greinacher rectifier circuit and balanced pi-type low-pass filter is described which supplies an X-ray tube 30 mA at 20 kV with a ripple of less than 0·02%. AUTHORS.

See also Abstracts 855, 858, 995, 1162, 1165, 1191, 1219, 1220.

HEAT.

CALORIMETRY.

1115. Specific Heat of Monel Metal between — 183° and 25°C. W. F. Hampton and J. H. Mennie. *Canad. J. of Research*, 7. *pp.* 677–679, *Dec.*, 1932.—The heat capacity of Monel metal is measured over the range — 183° to 25°C. and the specific heats are calculated. A. S. C. L.

1116. Quantum Theory of Latent Heat. H. C. Kudar. *Zeits. f. Physik*, 79. 7–8. *pp.* 529–531, *Dec.* 3, 1932.—In this preliminary communication the lines are set out on which it is proposed to explain Richard's rule L/T = constant, where L is the molar latent heat of fusion and T the absolute melting point. J. H. A.

1117. Calorimetric Determination of the Intrinsic Energy of Gases as a Function of the Pressure. F. D. Rossini and M. Frandsen. *Bureau of Standards, J. of Research*, 9. *pp.* 733–747, *Dec.*, 1932.—The intrinsic or internal energy U of air, oxygen and mixtures of O_2 and CO_2 (to 37 mole %), has been determined calorimetrically as a function of the pressure, to 40 atmospheres, at 28°C. Within the limits of error of the measurements $(\partial U/\partial \rho)_T$ is constant over the given range; and its values for the different gases, at 28°C., 0 to 40 atmospheres, in joules per atmosphere per mole, are: air, — 6·08; O_2, — 6·51; 0·075 CO_2 and 0·925 O_2, — 7·41; 0·175 CO_2, and 0·825 O_2, — 8·74; 0·231 CO_2 and 0·769 O_2, — 9·58; 0·366 CO_2 and 0·634 O_2, — 12·04. These values are estimated to be accurate within $\pm 2\frac{1}{2}\%$. The data on the mixtures of O_2 and CO_2 can be represented by the equation $(\partial U/\partial \rho)_{301°K} = -6{\cdot}51 - 11{\cdot}0x - 11{\cdot}0x^2$, where x is the mole fraction of CO_2. The value of $(\partial U/\partial \rho)_T$ for air, O_2, and the mixtures of O_2 and CO_2 at other near temperatures can be computed by means of the temperature coefficient of $(\partial U/\partial \rho)_T$ given by Washburn [see Abstract 283 (1933)], namely, — 0·4% per degree. AUTHORS.

See also Abstract 1056.

CONDUCTION.

1118. Conduction of Heat in Lead-Thallium at Low Temperatures. W. J. de Haas and H. Bremmer. *K. Akad. Amsterdam, Proc.* 35. 3. *pp.* 323–328, 1932. *Comm. No.* 220*c from the K. Onnes Lab., Leiden.*—The thermal resistance of the alloy $PbTl_2$ has been studied at low temperatures, by methods similar to those used in studying lead, tin and thallium individually [see Abstract 3324 (1932)]. Lead itself has a transition point at 7·2°K., the compound at 4·09°K., and pure thallium at 2·37°K. The thermal resistivity of $PbTl_2$ below 2·37°K. falls with increasing temperature; at that point it increases discontinuously, then rises until 4·09°K. is reached, when it commences to fall almost linearly. There is, however, no abrupt change in value at 4·09°K. The resistivity increases linearly with an applied magnetic

field at both the temperatures 2·0°K. and 3·16°K., *i.e.*, below and above the discontinuity. J. H. A.

See also Abstract 957.

CONVECTION.

1119. Natural Convection of Heat when the Heating is Very Small. Comparison of the Limiting Value of the Convection with the Thermal Conduction of the Medium. P. Vernotte. *Comptes Rendus*, 195. *pp.* 1245–1247, *Dec.* 19, 1932.—Theoretical reasoning shows that the coefficient of apparent convection (the ratio of the energy dissipated by apparent convection to the difference of temperature between the hot body and the medium) must vary as the fourth root of this temperature difference. Experiments are described to test this point, the heated body being in the form of a small electrically heated furnace, suspended in a copper enclosure. When the heating became very small, the greatest precautions were taken as to the temperature measurements, and it is concluded that the theory of convection is insufficient to explain the effects when the difference of temperature between the hot body and the medium become very small. In particular, the value of the convection does not tend to become infinitely small as the conduction approaches zero. T. B.

DILATATION.

1120. Non-Uniform Expansion of Zinc Crystals. R. Becker and E. Orowan. *Zeits. f. Physik*, 79. 9–10. *pp.* 566–572, *Dec.* 15, 1932.—Under certain conditions it is found that the expansion curve of single crystals of zinc is not smooth, but exhibits several more or less sharp jumps whose steepness increases rapidly with increase of temperature. A description is given of apparatus for investigating this effect and typical curves are reproduced. Under conditions approximating to those usually obtaining in expansion measurements the jumps were smaller and their number was so great that the effect approximated to continuous flow. A. W.

See also Abstract 866.

EVAPORATION.

See Abstracts 973, 1190.

MELTING AND BOILING POINTS.

1121. New Cryoscopic Method. A. Lalande. *Comptes Rendus*, 195. *pp.* 1267–1269, *Dec.* 19, 1932.—Describes experimental technique for determining accurately the initial freezing point of a liquid mixture, with no risk of error due to super-cooling. The mixture being below the freezing point, equal small amounts of heat are added at selected times, equilibrium being established after each addition. The freezing point is then deduced from the intersection of the time-temperature curves which hold below and above that point respectively. J. H. A.

1122. Lecture Demonstration of Gas-Liquefaction. H. Keefer. *Phys. Zeits.* 33. *pp.* 967–968, *Dec.* 15, 1932.—Details are given of an experimental arrangement, suitable for exhibition before an audience, whereby the liquefaction of carbon dioxide in a glass container may be realised by a simple procedure. H. H. Ho.

See also Abstracts 821, 1116, 1136, 1182.

TEMPERATURE, MEASUREMENT OF.

1123. Coiled-Filament Resistance Thermometers. C. H. Meyers. *Bureau of Standards, J. of Research*, 9. *pp.* 807–813, *Dec.*, 1932.—Platinum resistance thermometers with strain free windings which are smaller than those previously used are described, and the method of construction is given. By double helical winding the coil of a 25-ohm thermometer is reduced to about 5 mm. diameter and 2 cm. length, and the outside diameter of the thermometer is about the same as that of the ordinary mercury-in-glass thermometer. These thermometers are hermetically sealed, and thermometric lag is reduced by filling them with helium. AUTHOR.

1124. Theory of Thermopiles and Bolometers. J. Fischer. *Ann. d. Physik*, 15. 8. *pp.* 861–880, *Dec.*, 1932.—Various assumptions permit of the formation and integration of a differential equation giving the rise in temperature of the receiving strip of such instruments as bolometers and thermopiles. The sensitivity of simple radiation receivers is considered and also that in two special cases—one in which a small central portion only of the strip is irradiated and the other in which the portion receiving the radiation is not central. G. G. S.

See also Abstracts 882, 1016.

THERMOCHEMISTRY.

1125. Heats of Solution of Water Vapour. R. P. Bell. *Chem. Soc., J. pp.* 2905–2911, *Dec.*, 1932.—Heats of solution of water in various liquids are measured by an indirect method, and the results are discussed. A. S. C. L.

1126. Mechanism of Flame Movement. Part II. H. F. Coward and F. J. Hartwell. *Chem. Soc., J. pp.* 2676–2684, *Nov.*, 1932.—During the uniform movement of flame in mixtures of methane and air [see Abstract 4664 (1932)] in tubes of diameter 2·5–10 cm., and probably outside these limits, the volume of gas burnt in unit time is proportional to the area of the flame front, as determined by the diameter of the tube and by convection currents set up by the difference in density between the burnt and unburnt gases. The uniform movement of flame, established soon after ignition at the open end of a tube closed at the other end, is characterised by constant dimensions of the flame-front, these being maintained by a balance between the effects of a constant speed of propagation of flame normal to the flame-front and a steady operation of the convection effect. As the flame travels, the uniform movement develops into a vibratory movement, the volume of gas burnt per unit area of flame in unit time being probably the same as before. As the effect of gentle turbulence due to convection is to increase the rate of consumption of the mixture solely by increasing the area of the flame-front, that of violent turbulence, as in the cylinder of an internal-combustion engine, is probably due to the same cause. If these results are representative of non-detonating gaseous explosions in general, it follows that the rate at which flame consumes a gaseous mixture is directly proportional to (1) the fundamental speed of propagation of the flame in that mixture, layer by layer, at the temperature and pressure just in front of the flame and (2) the area of the flame-front. For sufficiently actinic flames, these are determinable by measuring snap-shot photographs of flame during the phase of uniform movement. T. H. P.

1127. Propagation of Flame in Electric Fields. Part II. Effects of Transverse Fields. E. M. Guenault and R. V. Wheeler. *Chem. Soc., J. pp.* 2788–2793, *Nov.*, 1932.—In addition to the factors bearing on the speed of propagation of flame under any conditions, under the influence of an electric field [Abstract 2100 (1931)] the following factors may be presumed to operate: (*a*) Change in the speed of the chemical reactions owing to the movement of gaseous ions; (*b*) change in the movement of the flame gases owing to the mechanical pull of the field on the electrically charged positive ions; (*c*) alteration in the area of the flame surface as a result of (*b*). For studying the effects of transverse electric fields, the flames used were either moving downwards in a tube against a steady upflow of explosive mixture, or travelling upwards from an open to a closed end of a vertical tube, or travelling from the lower to the upper end of a closed vertical tube. The results indicate that, under the conditions employed, changes in the speeds of the flames following the imposition of transverse electric fields are due mainly to changes in their surface areas. The nearly constant relationship observed between the speed of flame under the influence of an electric field and the area of its surface with or without the field lead to the conclusion that the field has no effect on either the character or the speed of the chemical reactions. The changes noted in the shapes and areas of the flames are explainable as the result of a mechanical drag exerted by the field on the flame, which behaves as a positively charged mass of gas. T. H. P.

1128. Vibratory Movement in Flames. O. C. de C. Ellis and E. Morgan. *Faraday Soc., Trans.* 28. *pp.* 826–839, *Dec.*, 1932.—The vibratory movement is the term employed to describe the behaviour of the surface of a flame subsequent to its "uniform movement," along a tube that is open at its firing end. It vibrates longitudinally about its steady forward movement, suffering a constant change of area. The paper describes an investigation of the propagation of flame in mixtures of CO_2 and air in a horizontal tube, with special reference to the vibratory movement. In the theoretical section of the paper, the analyses show that under certain conditions of constant pressure the flame would propagate at constant speed. If, however, a displacement be applied to the system it is shown that vibrations are set up, and certain equations are deduced. When the vibrations are of small amplitude they are independent of the speed of propagation. When the vibrations are finite their amplitude and the speed of the flame are interdependent. Figures are given comparing analytical and experimental results, the latter being obtained from photographic records of flame-propagation in a mixture of CO and air containing 25% of CO_2. Good agreement is obtained. T. B.

1129. Propagation Tests and Photography of the Disturbance Emitted by the Explosion of Commercial Electric Detonators. D. B. Gawthrop. *Frank. Inst., J.* 214. *pp.* 647–664, *Dec.*, 1932.—A photographic study has been made of the disturbance sent out into the air when detonators of different chemical compositions are fired, and of the effects of such disturbances in producing detonation in a charge of explosive located at a distance from the detonator. It is concluded that (1) detonators containing a base charge of explosives such as tetryl or picric acid, primed with mercury fulminate or lead azide, transfer detonation over the greatest distances, the velocity of the particles sent out

by the explosion being 1200 m./sec. compared with 970 in other types of detonators; and (2) that the shock wave in air initiated by the explosion of an electric detonator has an average velocity of about 500 m./sec. for the first 30 cm., while the average velocity of the shock wave sent through a cellophane tube by the explosion of a shielded detonator is 1045 m./sec. T. B.

1130. Energy Exchange in Unimolecular Gas Reactions. O. K. Rice. *Am. Chem. Soc., J.* 54. *pp.* 4558–4581, *Dec.*, 1932—The rate constants for many unimolecular gas reactions decrease at low pressures as the number of activating collisions becomes small, but it is found that in a number of decompositions of organic compounds addition of sufficient hydrogen restores the rate constant to its high pressure value, the hydrogen being able to cause activation; helium does not possess this property. For a study of the above phenomena, an investigation is now recorded of the dynamics of energy exchanges between organic molecules of the type which undergo decomposition in the gas phase and other simple molecules, *e.g.*, hydrogen and helium, which may activate or deactivate the organic molecules. The calculations are based essentially on a simple one-dimensional model in which it is assumed that a particle collides with an oscillator along the line in which the latter is vibrating. The various factors which affect the probability of transfer of energy have also been investigated. It was found that, in general, increasing the force constant of the oscillator decreases the probability, increasing the sharpness of the collision increases the probability, and increasing the mass of the colliding particle decreases the probability. H. H. Ho.

See also Abstracts 1050, 1133, 1182.

THERMODYNAMICS.

1131. System Carbon Disulphide-Ethylene Dichloride. D. L. Hammick and J. Howard. *Chem. Soc., J. pp.* 2915–2916, *Dec.*, 1932. —On cooling to about — 50°C. two liquid phases separate. A minimum occurs in the composition/density curve in the region of equimolecular proportions. A. S. C. L.

1132. Thermodynamic Properties of Solid Solutions of Gold and Silver. A. Wachter. *Am. Chem. Soc., J.* 54. *pp.* 4609–4617, *Dec.*, 1932.—The thermodynamic properties of solid solutions of gold and silver were studied by means of measurements of the e.m.f. of cells of silver containing varying amounts of gold. The energy changes of solid silver upon dilution with gold were determined at mol fractions varying from 1·00 to 0·15, between the temperatures of 200°C. and 400°C. The solid solution containing 0·500 mol of silver was shown to be the most stable. The thermodynamic properties of these solid solutions are considered compatible with the existence of a regular arrangement of gold atoms in the silver crystal lattice. F. J. B.

1133. Free Energies of Formation of Various Forms of Lead Monoxide. H. M. Spencer and J. H. Mote. *Am. Chem. Soc., J.* 54. *pp.* 4618–4624, *Dec.*, 1932.—The free energies of formation at 25°C. of the various forms of lead monoxide, red and yellow, and the white hydrate, were determined by measurements of the e.m.f. of cells of the type: Pb (in het. amalg.), PbO (red, yellow, or hydrate), dil.$Ba(OH)_2$,

HgO (red), PbO (red, yellow, or hydrate), Hg. The results are compared with the free energies obtained from solubility measurements. F. J. B.

1134. Entropy, Heat Content and Free Energy of Iron. J. B. Austin. *Indust. and Engin. Chem.* 24. *pp.* 1388–1391, *Dec.*, 1932.—Tables of the entropy, heat content, and free energy of α- and γ-iron are given for the temperature range $-250°$ to 1600°C. The heat content-temperature curves for both forms of iron are shown in their correct relative positions. From the data tabulated it is shown that, in accordance with the prediction of thermodynamic theory, the heat of transition changes sign between the transition points. A double check is obtained on the validity of the third law of thermodynamics, *i.e.*, that at the absolute zero of temperature the entropy of a crystalline solid is zero. This law is found to hold good within the limits of error of the data. R. H. A.

See also Abstracts 1117, 1173.

VAPOUR PRESSURE.

1135. Partial Pressure and Distribution Coefficient of Acetic Acid over its Aqueous Solution at 25°C. K. Fredenhagen and H. Liebster. *Zeits. f. phys. Chem.* 162. *Abt. A.* 6. *pp.* 449–453, *Dec.*, 1932. —The first part of this paper is a short discussion of the measurement of solubility and a definition of the distribution coefficient, with a statement of the formula for dilute solutions for the work done in transferring a mole of substance from the gas to the liquid phase. The distribution coefficient is in most cases useless for determining the partial pressures due to inorganic salts. In the case of the strong halogen acids HCl, HBr, HI it can be used for dilute solutions, but the partial pressures are not available for calculating the distribution coefficient, since the concentration of the undissociated component in the solution cannot be determined. To determine the distribution coefficient over aqueous solutions, weak acids like acetic, HF and HCN are suitable. The rest of the paper gives the results of the measurements for acetic acid of concentrations from 0·018 to 2·54 normal. The partial pressures were determined by the dynamical method of Dolezalek, Gahl and Bates, and Mirchman. The results show that the distribution coefficient is not constant, but increases from 8·24 to $14·5 \times 10^4$ in the range of concentration covered. T. B.

1136. Distribution Coefficient of Hydrogen Fluoride over the Binary System (H_2O – HF) at 25°C. and the Boiling Point Curve of the System at Atmospheric Pressure. K. Fredenhagen and Marianne Wellmann. *Zeits. f. phys. Chem.* 162. *Abt. A.* 6. *pp.* 454–466, *Dec.*, 1932.—A determination is made of the distribution coefficient of HF over the system (H_2O – HF) from very small concentration up to very pure HF at a temperature 25°C. The method used is that of passing a known volume of gas over the solution until saturated and then absorbing the vapour taken up in another vessel and so determining its amount. The amount of HF absorbed is determined from conductivity measurements. A very careful determination of the dissociation constant of HF is made as its value is required in the calculation of the absorbed HF. Tables of results are given, also a curve showing the relation between the distribution coefficient and concentration in the liquid phase. This curve exhibits several peculiarities which are discussed. The boiling curve for the system (H_2O – HF) is also determined. This shows a maximum at a concentration of about 33 mol. per cent HF. T. B.

ACOUSTICS.

1137. Parabolic Surfaces in Acoustics. Y. Rocard. *Rev. d'Acoustique*, 1. *pp.* 222–231, *July*, 1932.—A theoretical investigation into the ratio of the sound pressure produced around the focus of a parabolic surface by plane waves incident thereon to that existing at the same point in the absence of the surface. The analysis, which is subject to certain simplifying assumptions, shows that for this amplification to be a maximum the aperture of the reflector should be twice its depth. The amplification produced when a source is placed at the focus of a parabola is also considered and a comparison is made between the author's theory and the experimental results of other workers. E. J. I.

1138. Velocity of Sound in an Absorptive Gas. D. G. Bourgin. *Phys. Rev.* 42. *pp.* 721–730, *Dec.* 1, 1932.—This paper continues the earlier mathematical work of the author [see Abstract 725 (1930)] who is endeavouring to link up experimental facts concerning the propagation of sound in gaseous media with the atomic qualities of the system. The method is based on the theory that velocity propagation in a gas is conditioned by internal energy exchanges subject to lags, and the present paper postulates three sets of states to interpret results where the wave period is of the order of the lag for some states. The results of Kneser [see Abstract 1675 (1932)] for CO_2 are examined in the light of this theory. E. J. I.

1139. Passage of Sound Waves through Anisotropic Media. G. v. Békésy. *Zeits. f. Physik*, 79. 9–10. *pp.* 668–671, *Dec.* 15, 1932.—It is pointed out that often the passage of sound waves through an anisotropic medium is of considerable importance, *e.g.*, in the case of musical instruments or of the transmission of sound through a complex partition. Waves in such a medium coming from a point source will have an elliptical form and the author, using a ripple tank in which it is arranged that its wave velocity should be 40 % less in one direction than in one perpendicular to it has been able to demonstrate this effect. An experimental proof, also obtained from a ripple tank, is offered of a theorem which states that the passage of waves through an anisotropic body can be made similar to that through an isotropic body by a suitable alteration of the position of the boundaries. J. E. R. C.

1140. Distribution of Sound Radiation from a Sphere Vibrating in Various Ways. Applications to Loud-Speaker Diaphragms. N. W. McLachlan. *Phil. Mag.* 14. *pp.* 747–758, *Nov.*, 1932.—By aid of Legendre functions formulæ are deduced for the acoustic pressure at a great distance from a sphere vibrating in various ways. Polar diagrams are given showing the distribution of radiation (*a*) for a sphere vibrating axially, (*b*) for a hemisphere vibrating axially, (*c*) for two hemispheres vibrating axially in opposition, and (*d*) for a sphere with two nodal circles. The results are applied to hornless loud-speakers. AUTHOR.

1141. Acoustic and Inertia Pressure at any Point on a Vibrating Circular Disc. N. W. McLachlan. *Phil. Mag.* 14. *pp.* 1012–1025, *Nov.*, 1932. *Supplement.*—A formula is obtained for the acoustic pressure

at any point on a rigid circular disc vibrating in an infinite plane. The analysis is extended to flexible discs whose dynamic deformation curve is taken to be of the form

$$w = \mathrm{A} \times \left(1 - p_1 \frac{r^2}{a^2}\right),$$

where p_1 is a variable parameter. It is shown that the acoustic and inertia components into which the pressure can be resolved vary from the centre to the edge. The expressions derived for the pressure in the cases considered involve Bessel, Struve, and hypergeometric functions. The results obtained are discussed with reference to the distribution of sound from the mouth of a long loud-speaker horn. By integrating the product of pressure and velocity over the surface of the disc the radiated power can be evaluated. As an example, the case of a free-edge disc vibrating with free centre and one nodal circle is treated. AUTHOR.

1142. Distribution of Sound from Vibrating Flexible Discs with Nodal Lines. N. W. McLachlan. *Ann. d. Physik*, 15. 4. *pp.* 422–439, *Nov.* 19, 1932.—The distribution of sound radiation from flexible discs vibrating in an infinite rigid plane and executing various symmetrical and diametral modes is treated analytically. To facilitate computation of the characteristics use is made of approximations for the dynamic deformation curves. The general case of a flexible disc without restriction as to frequency or edge conditions is treated rigorously by aid of Bessel and Neumann functions. The analysis is illustrated by appropriate polar diagrams showing typical radiation characteristics. In each series of polar curves comparison is made with the characteristic for a rigid disc. For a given amplitude the power radiated by the latter exceeds that from a disc having a nodal line. But by virtue of evanescence of the effective mass at a symmetrical mode of vibration the amplitude of a given force is so enhanced that the radiation is considerably in excess of that for the rigid disc, unless the transmission loss is unduly large. AUTHOR.

1143. Power Radiated from Vibrating Flexible Discs with Nodal Lines. N. W. McLachlan. *Ann. d. Physik*, 15. 4. *pp.* 440–454, *Nov.* 19, 1932.—Analytical expressions are found for the power radiated from free and clamped-edge flexible discs vibrating in different modes in a fluid. Owing to spatial interference the distribution of radiation is spherical at low frequencies only. To include all frequencies it is necessary to use series derived from the integration of squares and products of Bessel functions. For each mode of vibration the output is compared with that from a rigid disc having the same amplitude. It is shown that if the nodal circle on a free edge disc occurs at $r = a/\sqrt{2}$, the low-frequency power is a minimum, being only $\frac{1}{3450}$ that of a rigid disc, the central amplitude being the same in both cases. When $r = 0{\cdot}68a$ the power is increased 45-fold for the same amplitude of vibration. Owing to evanescence of the effective mass, the output of a certain aluminium disc with its nodal circle at $r = 0{\cdot}68a$ is shown for the same driving force to be three million times that of a rigid disc at 120 ~. This order of magnitude is obtained by experiment on the disc when driven by a circular coil, the radius of the nodal circle being $0{\cdot}5a$. It is shown that to obtain the greatest output from a flexible disc driven by a definite force, the periphery should be clamped and the disc should vibrate in its gravest mode. This is concomitant with a reduction in the bending stress. AUTHOR.

1144. Air Waves from Experimental Explosions. *Nature*, 130. *pp.* 1008–1009, *Dec.* 31, 1932.—For meteorological research during the Polar Year four explosions were made at Russian Harbour, Novaya Zemlya and at Oldebroek and undographs were used to record the air waves in Russia, Germany and Holland, and sound-ranging apparatus in Great Britain. Reports already available indicate that the Oldebroek explosions were not heard over a large area. No records were obtained in Great Britain, but infra-sonic waves seem to have occurred at Cambridge and Havering-atte-Bower, Essex. R. S. R.

1145. Diffraction of Light by Elastic Waves. R. Lucas. *Comptes Rendus*, 195. *pp.* 1066–1068, *Dec.* 5, 1932.—The diffraction spectra of different orders are accounted for mathematically, and their intensities approximately calculated, with results in fair agreement with experiment. [See also Abstract 4458 (1932).] C. A. S.

1146. Acoustics of Large Auditoria. S. Lifshitz. *Acoustical Soc. of America, J.* 4. *pp.* 112–121, *Oct.*, 1932.—An experimental investigation into the articulation field of a room 43,000 cu. metres in volume and notes on the musical optimum of reverberation. It is recommended that the walls of large rooms should coincide with curves of equal percentage articulation. E. J. I.

1147. Optimum Acoustical Damping for Rooms. H. Benecke. *Ann. d. Physik*, 15. 3. *pp.* 259–272, *Nov.*, 1932.—The optimum reverberation period for a room has been shown [see Abstract 2417 (1932)], to be given by the equation $T_{opt} = 0{\cdot}83 + 0{\cdot}041^3\sqrt{V}$, where V is the volume in cubic metres and T is the reverberation period in seconds. The above applies to large volumes ; for smaller volumes (less than 350 cubic metres) Lifschitz [see Abstract 2417 (1932)] believes that the value of T_{opt} is independent of the volume. By a detailed analysis of the process of building up the sound intensity in a room the author deduces the equation

$$T_n = \frac{6}{\log e} \times \frac{1}{\log_e\left(\frac{1}{p}\right)} \times (T_{a(p)} + l/c),$$

where T_n = reverberation period, l = length of the side of the room (supposed cubical), c = velocity of sound and $T_{a(p)}$ = time required for the sound intensity to build up to $(1 - p) \times$ the limiting intensity. Combining this equation with the Lifschitz equation, it is deduced that T_a should be, for all rooms, 0·06 sec. T_a (*Anhalldauer*) is the time required for the sound to build up to an intensity of 0·63 × the limiting intensity. This figure of 0·06 sec. is compared with the figure of 0·05 sec. given by Watson as the maximum time difference which may exist between the arrival of the direct and the reflected sound in order that reinforcement should take place, and it is suggested that by an inversion of the argument the Lifschitz law could be deduced theoretically. Several numerical examples are given. J. E. R. C.

1148. Transmission of Vibrations Through Solid Materials. B. E. Eisenhour and F. G. Tyzzer. *Frank. Inst., J.* 214. *pp.* 691–708, *Dec.*, 1932.—A vibrating mechanism is separated by a pad of solid material from a receiving device. The theory of the transmission of the vibrations through the pad is sketched in simple terms, and a series of tests upon different transmitting materials is made, in order to secure data for the design of vibration insulators. The results for a dozen substances are

represented graphically, and the natural frequencies of vibration of pads 1 in. thick, under various compressing loads, are given in a table. J. P. A.

1149. Evolution and Present State of Microphone Technique. P. Chavasse. *Rev. d'Acoustique*, 1. *pp.* 176–221, *July*, 1932.—An illustrated and comprehensive account of the subject. The history of the instrument is followed by an account of the principal characteristics of microphones and the methods employed in estimating these quantities. The microphones used in combination with receivers in the principal telephone systems are next described ; attention is directed to the properties of graphite and the form of diaphragms, and reference is made to the work and recommendations of the Comité Consultatif International. The remainder of the paper is concerned with microphones of high quality and, the carbon granule, the condenser and the electromagnetic types are described in detail. E. J. I.

1150. Directive Properties of Parabolic Reflectors. K. Satô and M. Sasao. *Imp. Acad. Tokyo, Proc.* 8. *pp.* 407–409, *Nov.*, 1932. *In English.*—Three aluminium mirrors of different shapes but with a constant diameter of opening of 40 cm. were used as reflectors and a small conical horn of 3 cm. diameter mounted to the reflector at its focus, acts as the receiver. The apparatus rotates horizontally about the centre of the opening. A plane wave is incident on the reflector. The results of sound intensity measurements are shown by polar diagrams. For each of the four pitches used the curves for each reflector are similar. Consequently the directive property of the reflector depends only slightly on the shape if the diameter of the opening is constant. The effect is similar to that for a conical horn of the same diameter and depth for all the pitches used. The parabolic reflector, however, gives less magnification for a constant depth and opening and is thus, conversely, an inferior collector or radiator of sound. [See Abstract 4445 (1932).] R. S. R.

1151. Structure of the Vowels. P. Kucharski. *Comptes Rendus*, 195. *pp.* 979–981, *Nov.* 21, 1932.—R. Paget has shown that vowel sounds contain two components, one lower in pitch caused by posterior resonance and one higher due to resonance of the front part of the mouth. The author forms vowel sounds synthetically by the use of oscillating circuits. Two such circuits are connected in parallel, and the resultant sound is emitted by a loud speaker which reproduces French vowel sounds in a satisfactory manner. In all cases there is a definite musical interval between the constituent tones for any given vowel, and the vowels can be classified according as the interval does or does not give rise to a difference tone which coincides with the fundamental of the harmonic series and which appears to be indispensable for the production of a vocal effect. This effect depends also on the relative intensities of the two constituents. If the " forming " interval is kept constant, the pitch of a given vowel may be varied within a given range, and a table of these is given for nine vowel sounds ; *e.g.*, vowel *a* as in papa ; forming interval a diminished seventh ; normal frequencies of components, 1060–1855 ; lower limit, 460–805 ; upper limit, 1680–2940. The nuances in vocal quality are ascribed to differences in the forming interval combined with variations in the relative intensities of the two laryngo-buccal resonance tones.

G. E. A.

See also Abstracts 874, 877, 959, 1238.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

1152. Measurement of the Phase Angles of Shielded Resistors. L. J. Berberich. *Physics*, 3. *pp.* 296–313, *Dec.*, 1932.—In this paper is discussed the problem of measuring the small, but not always negligible, phase angles of resistors, with special reference to shielded resistors or 100 ohms and above. Several types of shielded resistors are described briefly, among which is the ideally shielded, low phase-angle resistor, recently constructed by the writer. The substitution method developed is one in which the resistor, the phase angle of which is desired, is compared by means of a bridge circuit to a reference standard of a simple geometric configuration and of approximately the same resistance as that of the resistor. The results of measurements at 500 and 60 $\sim$ on three ideally-shielded resistors are given. By a series connection of resistors it is possible to extend the range of the method to 50,000 ohms. AUTHOR.

See also Abstract 1114.

CONDUCTION AND DISCHARGE IN GASES.

1153. Electrical Conductivity of Ionised Gas in the Presence of a Magnetic Field. T. G. Cowling. *Roy. Astron. Soc., M.N.* 93. *pp.* 90–98, *Nov.*, 1932.—A method for calculating the conductivity is given and numerical values for conditions approximating to those found in the solar reversing layer are calculated. The theory is also applied to the consideration of the turbulent motion of gas in a magnetic field in the reversing layer. It is concluded that the dimensions of masses of gas in motion must be large compared with 1 km. G. C. McV.

1154. Time-Lag in the Commencement of the Discharge in a Hot-Kathode Tube at Low Gas Pressures. W. Koch. *Phys. Zeits.* 33. *pp.* 934–937, *Dec.* 1, 1932.—Potential-time oscillograms are given showing the time-lag between application of the potential and commencement of the discharge. The first oscillogram is taken with the gas at a pressure of 10^{-2} mm. of Hg. and an electrode separation of 6 cm. Before a discharge can occur the negative space-charge at the kathode must be diminished by the approach of positive ions. The time of actual discharge depends on the geometry of the apparatus, on the ionisation coefficient α and on the nature and pressure of the gas. After preliminary experiments on two-electrode tubes, the effect of a grid is shown. Most of the ionisation produced by the electron current to the anode occurs between the grid and the anode. The majority of the positive ions generated in this way are collected by the grid, which is more strongly negative than the filament (kathode). The effect of negative potentials of -1, -10 and -20 volts on the grid are shown in 3 oscillograms. The tube contains argon at about 10^{-1} mm. Hg : the anode potential is kept constant. The greater the negative potential, the longer is the time-lag. Similar results are obtained with Hg vapour. The last oscillogram is taken with the same grid and anode potentials, but with different grid resistances. The larger the resistance, the shorter is the time-lag.

Finally, an experimental arrangement is described for determining the time-lag by a ballistic galvanometer method : the results are of the same order of magnitude as those obtained with the oscillograph. F. C. C.

1155. Optical Investigations of Discharges with Condensed Sparks in Rarefied Gases. N. Ryde. *Zeits. f. Physik*, 79. 9–10. *pp.* 626–633, *Dec.* 15, 1932.—A method is described of determining the electric field in which the atoms move in the condensed discharge through Geissler tubes filled with rarefied gases. The distribution of the atoms among the various field-strengths and hence the mean field-strength may then be estimated. A line is selected from the spectrum of the gas which shows a simple and easily measurable influence by electric fields. By intensity measurements the true broadening of the line caused by the presence of inter-atomic fields is determined. From the relation between intensity and wave-length and a knowledge of the dependence of wave-length on field-strength the intensity distribution of the various field-strengths is calculated, and from this the mean field-strength is estimated. J. E. K.

1156. Accommodation Coefficient of Gaseous Ions at Kathodes. K. T. Compton. *Nat. Acad. Sci., Proc.* 18. *pp.* 705–711, *Dec.*, 1932.—Recent determinations of the accommodation coefficients of He ions on a Mo kathode by a pressure method are shown to be of the same order as those previously obtained by other methods [see Abstract 3572 (1931)]. Zener has recently developed a quantum theory of the accommodation coefficient [see Abstract 3811 (1932)]. For simplicity he made calculations only for the degree of freedom normal to the surface. In dealing with ions, however, whose effective temperature greatly exceeds that of the solid, it would appear legitimate to apply the simpler classical principles, for the same reasons that these principles may be applied at high temperatures to specific heats. The most striking results of this theory are (1) the conclusion that there is no rebound if M_s, the mass of the surface atom, is less than M, the mass of the impinging molecule, and (2) the conclusion that the accommodation coefficient α is smallest for light ions. It would thus be expected that α would approximate to unity if the mass of the ion exceeds that of the surface atom. Certain experimental results lend support to this conclusion, and all the evidence at present available is in agreement with the second conclusion. A. W.

1157. Kathode Sputtering. F. H. Newman. *Phil. Mag.* 14. *pp.* 1047–1049, *Dec.*, 1932.—Notes on various aspects of kathode sputtering. The use of inert gases and of preheating is discussed. Apparatus suitable for the sputtering of mirrors is described. A. H.

1158. Contribution of Positive Ions to the Space-Current in the L.V. Arc. A. Gehrts and H. Vatter. *Zeits. f. Physik*, 79. 7–8. *pp.* 421–435, *Dec.* 3, 1932.—The authors give measurements of the amount of heat generated or absorbed at the heated kathode in a l.v. discharge in argon, neon or helium. The change of temperature of the kathode when space-current passed, was observed with an optical pyrometer and the change in the kathode heating current, in the absence of the space-current, to produce the same temperature change, was measured. The heat generated at the kathode depends on the number of positive ions incident and their ionisation potential, on the number of electrons emitted and their exit work, and on the heat developed by the passage of the space-

current along the kathode. It was also necessary to allow for the kinetic energy transferred to the kathode by the incident positive ions. The first measurements were made using a thoriated molybdenum kathode and applying a.c. between the kathode and the two anodes. For all three gases the proportion p of the space-charge carried by the positive ions was determined to lie between 10 and 20 %, which for other reasons appeared too high. Later measurements using an indirectly heated equipotential oxide kathode and applying d.c. between anodes and kathodes were found to be more satisfactory. These indicated that for low currents the discharge is almost entirely electron emission ($p = 0{\cdot}5$ %), but at a certain critical current the proportion of positive ions increases and tends to a limit of the order $p = 5$ %. Below the critical current the voltage drop in the tube was about equal to the ionisation potential of the gas (for argon, 15 volts) but at higher currents it dropped abruptly to the low value characteristic of the abnormal l.v. arc (in argon, 5 to 6 volts).

W. S. S.

1159. Spectral Zones in Front of the Kathode in Glow Discharges. A. Güntherschulze and F. Keller. *Zeits. f. Physik*, 79. 9–10. *pp.* 563–565, *Dec.* 15, 1932.—In a previous paper [Abstract 2975 (1932)] an account was given of a narrow, sharply defined and brilliant green zone in front of a Mg kathode in a glow discharge. A similar zone was found with Na and Li, but photographs could not then be obtained. By reducing the size of the kathode and improving the optical arrangements it has now been found possible to photograph these zones, using suitable gas pressure in the discharge tube, with exposures as short as 3 sec. Better results are, of course, obtained with longer exposures. Photographs are reproduced showing the narrow zone found in H in front of a Na kathode.

A. W.

1160. Behaviour of Electrons in Nitrous Oxide. V. A. Bailey and J. B. Rudd. *Phil. Mag.* 14. *pp.* 1033–1046, *Dec.*, 1932.—The authors describe experiments on the motion of electrons in nitrous oxide, which lead to the determination of the following quantities: u, the mean velocity of agitation of an electron; L, its mean free path at 1 mm. pressure; λ, the mean fraction of its own energy which is lost at a collision with a molecule; h, the probability of a negative ion being formed at a collision. These quantities are obtained as functions of Z/p, where Z is the applied electric force and p is the pressure of the gas. Plotting λ against u, λ exhibits a marked maximum at $u = 3 \times 10^7$ cm./sec. and a weaker maximum at $u = 7 \times 10^7$ cm./sec. The former corresponds approximately to an electronic energy equal to the quantum of radiational energy of the wave-length of the centre of the strongest infra-red absorption band in N_2O.

W. S. S.

1161. Ionisation of Gases by Electrons at High and Low Pressures. K. Masch. *Zeits. f. Physik*, 79. 9–10. *pp.* 672–675, *Dec.* 15, 1932.—The theoretical formula, $\alpha/p = C_1 e^{-pC_2/X}$ is investigated for oxygen and air at high and at low pressures (α = the electron ionisation coefficient, p = the pressure, X = the field strength, C_1, C_2 being constants). The formula is valid in the case of nitrogen in the pressure range 8–2000 mm. Less ionisation is produced in oxygen on account of its higher electron affinity, but in strong fields the lower ionisation potential of oxygen causes more

ionisation than is the case for nitrogen. Thus the formula is obeyed by oxygen only between certain limits. The ionisation in air is a mean between that of oxygen and that of nitrogen. J. E. R. C.

1162. Proposed Unit for Ionisation Intensities in Gases. W. Kolhörster. *Zeits. f. Physik*, 79. 9–10. *pp.* 682–683, *Dec.* 15, 1932.—It is proposed that all measurements of the ionisation potential produced in gases should be reduced to 0° C. and 760 mm. pressure. In cases in which this reduction is not possible the figure expressing the ionisation intensity should be followed by the absolute temperature and pressure in brackets. If a gas other than air is used the chemical formula of the gas, in parenthesis, should follow the figure. It is proposed that the letter I, written after the figure expressing the number of ions per cc. per sec., should be used to designate the unit. J. E. R. C.

1163. Highly Rarefied Flames of Potassium Vapour with Halogens. M. Krocsák and G. Schay. *Zeits. f. phys. Chem.* 19. *Abt.B.* 5. *pp.* 344–365, *Dec.*, 1932.—The method of highly rarefied flames is applied to the investigation of the reactions $K + Br_2$ and $K + Cl_2$. The mechanism of the chemical reaction is analogous to that of the corresponding sodium flames, but on the other hand the mechanism of the chemiluminescence is much more complicated. The light emission of these flames consists of three parts: (1) the red resonance doublet of potassium; (2) the second violet resonance doublet; and (3) a continuum that extends over practically the whole visible spectrum and which may be identical with the well-known continuum in the flame spectrum of potassium. On the basis of the observations the mechanism leading to the appearance of all three kinds of emission is discussed, In further contrast with the corresponding sodium flames the potassium-halogen flames possess a considerable electron-conductivity. J. E. K.

1164. Activation of Molecular Oxygen by Electron Impact. G. Glockler and J. L. Wilson. *An. Chem. Soc., J.* 54. *pp.* 4544–4558, *Dec.*, 1932.—Activation of oxygen molecules by electrons of known speeds (3–20 e. volts) has been studied and the activated species removed by further reaction on a mercury surface. Activation is found possible in the whole range of energies studied, and is interpreted on the basis of the energy diagram of molecular oxygen derived from its band spectrum. In the low-velocity region (3–8 e. volts)metastable ($^1\Sigma_g^+$) oxygen molecules serve as the activated state, in the region from 8–12 e. volts, electronically excited molecules ($^3\Sigma_g^-$) are the activated species, and above the ionisation potential (12·5 e. volts) ions (O_2^+) enter the reaction. These various activations are discussed in terms of probabilities of energy transfer from electrons to normal molecules and of probabilities of further reaction between activated states and a mercury surface. H. H. Ho.

1165. Powerful Kathode-Ray Tube. Y. Cauchois. *J. de Physique et le Radium*, 3. *pp.* 512–519, *Nov.*, 1932.—The design of a new Lenard-Coolidge tube is given in detail. The tube works at voltages ranging from 40,000 to 125,000 V. The power of the external beam is of the order of 100 W. The method of functioning is described and the output is given in graphical form. The author also gives precautions to be adopted in using the tubes. H. L. B.

See also Abstracts 1019, 1036.

CONDUCTION IN SOLIDS AND LIQUIDS.

1166. Theory of Metals. Part I. A. H. Wilson. *Roy. Soc., Proc.* 138. *pp.* 594–606, *Dec.* 1, 1932.—The author develops *ab initio* the wave mechanics theory of electrons in metals with special reference to the debatable points in the previous treatments of Bloch and Peierls. The method used is analogous to that worked out for diatomic molecules. The vibrations of the atomic lattice are first worked out and then the electronic wave functions are derived treating the co-ordinates of the atomic nuclei merely as parameters and applying perturbation theory. The method leads to the evaluation of the " mean free path " of the electrons. The final results are similar to those of Bloch and lead to a conductivity which varies as T^{-1} for high and as T^{-5} for low temperatures. The refinements in the theory introduced by Peierls are shown to be invalid, and the theory is in consequence simplified. W. S. S.

1167. Electrical Properties of Dilute Solid Solutions. Part III. Resistance of Copper and Gold Alloys. Regularities in the Resistance Increments. J. O. Linde. *Ann. d. Physik,* 15. 2. *pp.* 219–248, *Nov.*, 1932.—The atomic resistance increments in copper of the metals of atomic number 25–33, 45–51 and 77–80 have been measured at 18° C. The results for gold alloys already published [see Abstracts 3910 (1931) and 5169 (1932)] have been extended to include Ti, Cr, Mn, Zn, Ga, Ge, Cd and Hg. The temperature coefficients of resistance over the range + 18° C. to −190° C. have been determined for several alloys. A general discussion is given of all the results obtained for alloys of gold, silver and copper. F. J. W.

1168. Electrical Conductivity of Graphite Powder. Z. Specht. *Zeits. f. Elektrochem.* 38. *pp.* 920–925, *Dec.*, 1932.—In experiments on the effect of pressure on the electrical resistance of powdered graphite in the form of small rods Ryschkewitsch found the relation $\sigma = a/p + b$, where σ = specific resistance, p = pressure, and a and b are constants. The constant b is a measure of the specific resistance of the powdered graphite when its grains are in direct contact with one another and yet do not form a compact mass. Ryschkewitsch found b to be identical for all sorts of graphite and its approximate constant value to be $b = 0{\cdot}0075$ ohm. cm. The author has confirmed these results and extended the investigation to various specimens of graphite. The constant a for graphite from different regions was found to be as follows : Ceylon, $0{\cdot}31$; Korea, $0{\cdot}85$; Acheson, $1{\cdot}15$; Steiermark, $1{\cdot}95$; Spain, $3{\cdot}35$. The values found for b were nearly equal to Ryschkewitsch's constant $0{\cdot}0075$ ohm. cm. J. J. S.

1169. Current Conduction in a Dielectric in which the Ions are Derived from an Electrode. W. O. Schumann. *Ann. d. Physik,* 15. 7. *pp.* 843–860, *Dec.*, 1932.—In the investigation of the conductivity of insulating substances phenomena sometimes appear which allow the supposition that the electrodes are the " sources " of the current, *i.e.*, that the carriers which transport the current arise there. In this paper a theoretical discussion is given of the phenomena which occur if a definite mobility is ascribed to the carriers. Two cases are considered : (1) when both kinds of carriers are assumed to exist, but only the positive to be mobile ; (2) when only positive carriers are assumed, which have their origin at the anode. J. J. S.

1170. Current Conduction in a Dielectric where Only One Ion is Free. W. O. Schumann. *Zeits. f. Physik*, 79. 7–8. *pp.* 532–549, *Dec.* 3, 1932.—Many poor conductors, particularly crystals, show a conductivity which is best explained on the assumption that one only, say the positive, of the ions, is free to travel through the lattice. The behaviour of a medium so constituted is investigated mathematically. J. H. A.

1171. Elimination of Disturbing E.M.F.s with Sensitive D.C. Measurements. L. Ebert and J. Lange. *Zeits. f. Instrumentenk.* 52. *pp.* 552–553, *Dec.*, 1932.—The authors reply to some criticisms of W. P. White on their short-circuiting switch method of eliminating disturbing e.m.f.s [see Abstracts 3601 (1931) and 4624 (1932)]. They note that errors in the use of their arrangement can be avoided. J. J. S.

1172. Improved Conductivity Cell. B. Moore. *Journ. Sci. Instruments*, 9. *pp.* 389–390, *Dec.*, 1932.—The electrodes consist of two pieces of platinum-iridium foil sealed to the end portions of a glass rod with a gap between ; the rod is attached above and below to tubes, the lower of which is bent round in U-shape so that its free end is level with the upper end of the other ; both are attached rigidly at these upper ends to the stopper of a suitable container, to hold the liquid under examination. The tubes contain mercury in electrical connection with the electrodes. Such a cell is suitable for routine determinations of electrolytes. C. A. S.

See also Abstracts 827, 828, 843, 884, 893, 1014, 1118, 1203, 1204, 1234.

DIELECTRICS AND CAPACITANCE.

1173. Dipole Rotation in Crystalline Solids. C. P. Smyth and C. S. Hitchcock. *Am. Chem. Soc., J.* 54. *pp.* 4631–4647, *Dec.*, 1932.—The dielectric constants and specific conductances have been measured over a wide range of temperature and frequency for several substances in the solid state and for certain of them as liquids near their melting points. As the temperature is lowered there is no sudden increased formation of molecular aggregates. The evidence of Wolfke and Mazur for a second liquid phase in nitrobenzene has not been substantiated. Impurities have a great influence on the dielectric constant of a solid measured at low frequencies. No evidence has been found for the rotation of large polar molecules in solids. Ice behaves like a very viscous liquid and shows rotation in confirmation of previous results. Only in dimethyl sulphate was there found rotation of small polar groups ; and in this case dipole orientation is exhibited down to — 70° C. W. R. A.

1174. Dielectric Constant and Particle Size. J. W. Williams and J. L. Oncley. *Physics*, 3. *pp.* 314–323, *Dec.*, 1932.—Orientation of a particle in an alternating electric field takes a finite time owing to viscous resistance to its rotation in the medium. The variation of observed dielectric constant with frequency will show, therefore, a decrease with increasing frequency at some point. Debye's dipole theory is applied to calculate molecular weights from such data. The values are only approximate owing to doubt about the correct value for the viscosity term and to deviation from the Clausius-Mossotti relation. Mono- and poly-disperse systems are readily distinguished by the method, since the dielectric constant/frequency curves are flattened out by polydispersity ; the single curve really being a sum of the curves of all sizes of particles present.

A. S. C. L.

1175. Dielectric Constants of the Aqueous Solutions of Some Amino-Acids and Polypeptides. M. Frankenthal. *Zeits. f. phys. Chem.* 19. *Abt. B.* 5. *pp.* 328–344, *Dec.*, 1932.—The dielectric constants in relation to the concentrations of the various solutions were determined in order to test the theory of amphoteric ions. Measurements were made by the second Drude method, and the results indicate that amino-acids and polypeptides increase the dielectric constant of the solvent whilst glycine anhydride lowers it. The dielectric constants of the solutions appear to approach a saturation value with rising concentration, which is attributed to a decrease of the relative amphoteric ion concentration with rising total concentration. The data now obtained are compared with published results and deviations therefrom are discussed. H. H. Ho.

1176. Importance of Dipole Measurements for the Stereochemistry of Carbon. E. Bergmann and W. Schütz. *Zeits. f. phys. Chem.* 19. *Abt. B.* 6. *pp.* 389–404, *Dec.*, 1932.—Three further papers are published. The first deals with *p*-substituted phenylazides, and carbodianil and its di-*p*-methyl derivatives; the second with substituted ethylene oxides; and the third with mercury diphenyl and diethyl, and with the triphenyls of the fifth group of the periodic table. The methods of preparation are given, and experimental data are used to elucidate the structure of the different molecules. [See also Abstract 4482 (1932).] W. R. A.

1177. Electric Moments of Cyclohexane Derivatives. O. Hassel and E. Naeshagen. *Zeits. f. phys. Chem.* 19. *Abt. B.* 6. *pp.* 434–442, *Dec.*, 1932.—A new apparatus is described briefly. The electric moments of 14 substances, mostly derivatives of cyclohexane, are reported. W. R. A.

1178. Studies in Dielectric Polarisation. Parts II, III and IV. E. C. E. Hunter and J. R. Partington. *Chem. Soc., J. pp.* 2812–2829, *Dec.*, 1932.—In Part II it is recorded that the dipole moments of ethyl, n-propyl, and n-butyl mercaptans and of thiophenol in benzene solutions are approximately constant, and larger than that of hydrogen sulphide [see Abstract 4267 (1931)], whilst that for acetonitrile is in agreement with Werner's value and lower than Williams' result. The chemical and physical properties of the mercaptans and alcohols are also discussed, and an explanation offered for the difference in molecular complexity of these compounds. In Part III it is shown that there is an increase in dipole moment from methyl to ethyl sulphide, the moments of the higher sulphides remaining constant, whilst a comparison of the ethers and sulphides seems to indicate that the valency angles of oxygen and sulphur in these compounds are different for the aliphatic and for the aromatic compounds. Part IV records an increase in moment from methyl *iso*thiocyanate to ethyl *iso*thiocyanate, which is probably due to induction along the hydrocarbon chain. The moment of allyl *iso*thiocyanate shows little difference from that of the ethyl compound, indicating that the double bond in the β-position is not influenced by the principal dipole. The *iso*thiocyanate group is best represented by a rod-like structure. Methyl and ethyl thiocyanates have moments nearly equal to that of the phenyl compound. The absence of inductive effects in this case is no doubt due to the inclination of the polar group to the hydrocarbon chain, and this conclusion finds qualitative support in the calculated angle of the sulphur valencies in the thiocyanate group. H. H. Ho.

1179. Electrostatic Theory of the Frequency-Dependence of Ionic Mobilities and Dielectric Constants in Mixed Solutions of Strong Electrolytes. H. Falkenhagen and W. Fischer. *Phys. Zeits.* 33. *pp.* 941–945, *Dec.* 1, 1932.—This paper gives the general theory for a series of forthcoming papers on the subjects in the title, and deals with the general differential equations of the problem. In particular, the calculation of the distribution functions and the evaluation of the additional potential about an ion and the force acting thereon are given. **Errata,** *ibid. p.* 968, *Dec.* 15, 1932. H. H. Ho.

See also Abstracts 1188, 1189, 1238.

ELECTROCHEMISTRY.

1180. Electrolysis of Dry Liquid Ammonia. R. Coustal and H. Spindler. *Comptes Rendus*, 195. *pp.* 1263–1264, *Dec.* 19, 1932.—When dry liquid ammonia is electrolysed with a p.d. of from 2 to 8000 volts no definite counter e.m.f. is indicated, and Ohm's law is not obeyed, the current increasing less rapidly than the p.d. With a current of a few mA, anodes of Cu, Au, or Ag are rapidly reduced to a powder which on heating evolves ammonia leaving the metal; graphite behaves similarly. Sb, Fe, Mo, Ni-Cr, Pt, Te, and W are more resistant, but all become covered with a yellow film; Ni with a white substance which turns violet on hydration, and is converted by HNO_3 to a yellow plastic material not attacked by HCl or H_2SO_4, but soluble in aqua regia; heated above 300° it leaves the metal. C. A. S.

1181. Association of Strong Electrolytes. J. Zirkler. *Zeits. f. phys. Chem.* 163. *Abt.A.* 1. *pp.* 1–7. *Dec.*, 1932.—The degrees of association of barium nitrate, calculated from the temperature coefficients of the electrical conductivity, agree approximately with those furnished by the temperature coefficients of the heat of dilution. On the basis of this agreement, the conductivity method is applied to other electrolytes. The differences between the measured heats of dilution and those determined in this way exhibit certain regularities and are attributed to the heats of solvation of the ions. T. H. P.

1182. Activity Coefficients of Potassium Chloride. H. M. Spencer. *Am. Chem. Soc., J.* 54. *pp.* 4490–4497, *Dec.*, 1932.—The activity coefficients of potassium chloride in aqueous solutions at 25° C were determined by means of freezing-point measurements, including the recent measurement of Jones and Bury, and by Karagunis, Hawkinson and Damköhler. Corrections were made for the heats of dilution. F. J. B.

1183. Electromotive Behaviour of Nickel and Cobalt. E. Müller and J. Janitzki. *Zeits. f. phys. Chem.* 162. *Abt.A.* 6. *pp.* 385–397, *Dec.*, 1932.—In electromotive behaviour, nickel and cobalt are analogous to iron. They are active only at charged places, so that the compact metals in solution show only a limiting potential, at which the velocity with which their ions pass into solution is equal to that with which the hydrogen, discharged thereby, diffuses out. When subjected to friction in solutions of acids, bases or their neutral salts, the three metals behave similarly, the sluggishness in their electromotive activity being removed and their potential forced back to the reversible value. The effect of friction depends on a continued production of new charged spots. The

differences observed in the behaviour of the three metals are attributed to the different degrees to which they are charged and to the different positions of their reversible potentials. Certain phenomena still remain to be explained. With cobalt in its neutral salt solutions, the reversible metal-potential appears to be reached and in normal $CoCl_2$ solution, $\epsilon_H = -0 \cdot 292$ volt; with nickel, it is questionable if this occurs. T. H. P.

1184. Hydrogen Electrode in Chromic-Chromous Solutions. Solubility Product of Chromous Hydroxide. W. H. Bennett. *Faraday Soc., Trans.* 28. *pp.* 889–895, *Dec.*, 1932.—A mixed solution of chromic and chromous sulphates, prepared by electrolytic reduction of a saturated solution of chromic sulphate, with addition of 15 cc. H_2SO_4 per 100 cc., titrated with NaOH, aq. by means of a hydrogen (wire type), and a bright platinum electrode gave similar titration curves, that with the hydrogen electrode showing more clearly marked inflexions for the three stages of neutralisation, though too indistinct for quantitative work. The hydrogen electrode behaves as an oxidation-reduction electrode governed by the Cr''/Cr''' equilibrium until all $Cr(OH)_3$ is precipitated, and then normally. The pH of precipitation of $Cr(OH)_2$ from dilute $CrSO_4$, aq. is 5·6, which gives $2 \cdot 0 \times 10^{-20}$ as the approximate solubility product of $Cr(OH)_2$ at 18°. C. A. S.

1185. Improvements in the Hydrogen Electrode Used for Determining pH. P. L. du Noüy. *Comptes Rendus*, 195. *pp.* 1265–1267, *Dec.* 19, 1932.—If to the solution under examination there is added a small quantity (about 0·05 cc. to 0·4 cc. of solution) of Bredig's colloidal palladium and a small bubble of hydrogen the necessity of frequently replatinising the platinum electrode on account of its being "poisoned" by the solution is completely avoided. Equilibrium is somewhat slower in being established (10–20 min.), but otherwise the electrode acts normally. C. A. S.

1186. Unique Electrode Potential Characteristic of a Metal, and a Theory for the Mechanism of Electrode Potential. A. L. McAulay and E. C. R. Spooner. *Roy. Soc., Proc.* 138. *pp.* 494–501, *Dec.* 1, 1932.—Within certain limits the potential of a cadmium electrode in an air-free aqueous solution, *viz.*, 0·787 volt at 18° C against the normal calomel electrode, is independent of the composition of the solution, and therefore originates in an interaction between the metal and water only. It is suggested that owing to bombardment of the ions existing in the metal by the highly polar water molecules, a stream of ions is drawn into the solution until equilibrium is set up, the return of the ions to the electrode being caused by the action of the field resulting from their removal; the thickness of the layer of ions so produced is about 5×10^{-5} cm., and the concentration about 4×10^{-5} g.-mol. per litre. This hypothesis is supported by study of the influence of the concentration of the metal ion in the solution, and of aeration of the solution; exposure to air causes the potential to become more positive and irreproducible, not because an impervious film is formed, but probably because the layer of ions becomes more concentrated. H. F. G.

1187. Electrolytic Polarisation. Part X. Ammines of Copper, Silver, Zinc and Cadmium. S. Glasstone. *Chem. Soc. J. pp.* 2849–2887, *Dec.*, 1932.—Electrometric titration, with ammonia solution, of solutions of copper, silver, zinc and cadmium salts containing an excess of ammonium sulphate, using the appropriate metal as indicator electrode,

indicates the existence of the ions $Cu(NH_3)_4^{\cdot\cdot}$, $Ag(NH_3)_2^{\cdot}$, $Zn(NH_3)_4^{\cdot\cdot}$, and $Cd(NH_3)_3^{\cdot\cdot}$ or $Cd[(NH_3)_3\ (H_2O)]$. There is no evidence that any of the intermediate processes in the deposition of the metal, such as the dissociation of these ammine ions, occurs slowly. H .F. G.

1188. A.C. Capacities of Electrolytic Condensers. F. W. Godsey, Jr. *Am. Electrochem. Soc., Trans.* 61. *pp.* 515–529, 1932.—Electrolyte potentials during formation of anode films in electrolytic condensers in a.c. circuits can be readily measured, and the effective formation voltage calculated therefrom. When such voltages are used in comparing capacities for d.c. and a.c. formation close agreement is obtained. The appearance of an alternating voltage component in the outer film layers necessitates division of the film into two major regions, *viz.*, the inner or rectifying region, and the outer layers. Calculation of the characteristics of these two regions with the aid of the measured electrolyte potentials as a factor shows that the boundary of the rectifying region moves about in the film, changing the thicknesses of the rectifying film and the outer layers through considerable limits for various operating conditions. If a constant specific inductive capacity throughout the film is assumed, the thicknesses of the respective films can be calculated accurately, with the exception of the condition of high power factor and therefore distorted current and voltage wave-shapes in the film. It is, however, probable that the specific inductive capacity varies largely throughout the film, owing to the greater saturation of the outer film layers with the electrolyte solvent. The behaviour of the rectifying and outer layers of the anode film indicates a film in which there is ionisation in the outer layers owing to penetration of the film by the electrolyte solvent and ions of the electrolyte, the extent of penetration being a variable dependent on many factors. Such a film structure coincides with the author's absorbed liquid theory.
T. H. P.

1189. Potential Gradients in Anodic Films. F. W. Godsey, Jr. *Am. Electrochem. Soc., Trans.* 61. *pp.* 549–559, 1932.—The three general theories of the operation of electrolytic condensers, *viz.*, the gas oxide, the solid oxide, and the absorbed liquid theories, are discussed. Application of the results of Joffé, Sinelnikov and Kurchatoff [see Abstract 2606 (1927)] concerning breakdown fields in very thin, artificially-formed films of insulating materials to the case of electrolytic condensers indicates that the gas oxide theory is untenable, owing to the high potential gradients encountered. whilst the solid oxide theory requires a very high dielectric constant for the oxide film. The film must, therefore, contain a certain proportion of the electrolyte solvent, held by either adsorption or absorption, this proportion being probably of the order 30 per cent by volume. The extremely high gradients encountered in the gas oxide and the solid oxide film in which the effective thickness is only 25 per cent of the gross thickness would cause complete orientation of polar molecules, with the attendant drop in capacity when the forming voltage is applied ; such decrease in capacity has, however, not been recorded. T. H. P.

See also Abstracts 828, 829, 830, 839, 897, 1170, 1175, 1179.

ELECTRONS AND PROTONS.

1190. Vaporisation Phenomena in Mercury Particles. A. Lustig and M. Reiss. *Zeits. f. Physik*, 79. 9–10. *pp.* 696–699, *Dec.* 15, 1932.—

The authors refer to two previous papers on this subject [see Abstracts 4425 and 4426 (1932)], by R. Nestle and K. Schaefer respectively, in which measurements of the charge upon particles of mercury were made by Ehrenhaft's method. A discussion of their errors is made, and it is suggested that their conclusion, *viz.*, that integral multiples of the electronic charge are found upon evaporating droplets only is not substantiated by their experimental results. J. E. R. C.

1191. Electron Interference and Röntgen Interference. F. Kirchner. *Ergeb. d. Exakt. Naturwiss.* 11. *pp.* 64–133, 1932.—A chapter consisting of a critical survey and discussion of the outstanding investigations in these branches of physics. The following sub-titles give a general idea of the scope of this article : Significance of Laue's theory of Röntgen interference for electron interference phenomena in crystals ; passage of electron-waves through thin crystals ; interference of diffuse beams ; reflection from thick crystals ; crystal surface as a 2-dimensional grating ; interference intensity and structure research ; applications of fast electron beams to structure research ; crystals in collodion films ; poly-crystalline films of various substances ; surface structure ; inner-atomic interference ; inner-molecular interference ; Röntgen interference ; electron interference. J. E. K.

1192. Polarisation of Electrons after Double Scattering at 90°. E. Rupp. *Zeits. f. Physik*, 79. 9–10. *pp.* 642–654, *Dec.* 15, 1932.—By a double scattering of fast electrons from gold an unsymmetrical reflection of electrons which are twice scattered in the same direction is observed, which, from experiments in a magnetic field, can be shown to be connected with the magnetic moment of the electrons. Experiments with 45° scattering at the analyser make it appear probable that the polarisation of electrons takes place at the atom nucleus but the variation of the polarisation with the velocity of the electrons does not agree with the theory of Mott. J. E. K.

1193. Recent Experiments on the Polarisation of Electrons. E. Rupp. *Phys. Zeit.* 33. *pp.* 937–940, *Dec.* 1, 1932.—The author refers to his earlier experiments [see Abstract 2558 (1932)] where the electrons scattered through 90° by a thin gold foil were passed through a second thin gold foil and an intensity variation was found around the diffraction ring pattern. In the present improved experiments, electrons scattered through 90° by a thin gold foil are re-scattered by either a gold or an aluminium wire. The intensities of the twice scattered electrons are determined in directions parallel and anti-parallel to the direction of the primary electron beam. The apparatus is adjusted until the ratios of the parallel to anti-parallel scattering are equal for gold and aluminium, using 20-kV electrons which are assumed to show no polarisation. When electrons with energy of 130 or 250 kV are used, this equality is not maintained, polarisation effects altering the ratio by 3–4 % and 9–10 % respectively. The polarisation is destroyed by passing the electrons through a magnetic field 10 cm. long and of intensity 440 gauss, the direct deflection being compensated electrostatically. The experiments are discussed with reference to Mott's theory of the polarisation of electrons by double nuclear scattering. F. C. C.

1194. Influence of Angular Distribution of Scattered Electrons on the Measurement of the Effective Cross-Section. R. Kollath. *Ann. d. Physik*, 15. 5. *pp.* 485–515, *Dec.*, 1932.—The effect of the size of

the slits used by various experimenters who have applied the Ramsauer method to determine the effective cross-section of gas molecules with respect to slow electrons is discussed theoretically. It is found that the two-chamber apparatus should be more accurate than the one-chamber apparatus. Calculations show that in some but not in all cases the differences may be accounted for if the finite width of the slit is taken into account. The discrepancies which occur in the results for the effective cross-section determined by the methods of Ramsauer and Townsend become less marked if the angular distribution of the electrons scattered by the gas molecules is taken into account. The author works out two methods for dealing with these discrepancies and states that one is considerably more satisfactory mathematically than the other. The application of the calculations to velocities less than one volt leads the author to conclude that at the lowest electronic velocities in hydrogen there should again be a strong forward scattering, as at the higher velocities. [See also Abstract 5217 (1932)]. H. L. B.

1195. Movement of Charged Particles in a Field of Suddenly Changing Potential. E. Persico. *N. Cimento*, 9. *pp.* 284–289, *Nov.*, 1932.—Considers the case of a particle travelling along a straight line at a point of which a sudden change of potential occurs. If the change exceeds the energy of the particle, then, according to the classical theory, the particle will be stopped at the point in question, whereas according to Schrödinger's equation the modulus ψ, the square of which measures the density of the particles, instead of being zero at the point, is represented by a decreasing exponential. The case is somewhat analogous to the penetration of light through a totally reflecting surface. The author studies the particular case where the curve of potential varies with the time, and asks what happens if the potential gradiant suddenly disappears. He finds that when the " potential mountain " has about twice the potential of the incident particles, the curve of ψ shows a decided rise at the point of transition, followed by waves of decreasing amplitude, finally reaching the level of the undisturbed particles. E. E. F. d'A.

1196. Theory of Geometric Optics for Electrons. J. Picht. *Ann. d. Physik*, 15. 8. *pp.* 926–964, *Dec.*, 1932.—The differential equation for paraxial electron rays is obtained and a general solution in series form derived. A solution of a particular case is given in a form suitable for numerical calculation. It is shown how a potential distribution may be calculated corresponding to a given focal length of an electric lens. Formulæ are also given for calculating the position of the focus and principal point of a given potential distribution. Formulæ developed by Gullstrand for optically heterogeneous media may be transferred to electron optics. [See also Abstract 2557 (1932).] A. W.

See also Abstracts 856, 1160.

ELECTROSTATICS.

1197. Field Due to Two Equally Charged Parallel Conducting Cylinders. H. Poritsky. *J. Math. Phys., Mass. Inst. of Technology*, 11. *pp.* 213–217, *Sept.–Dec.*, 1932.—A mathematical investigation. It is shown that the case of equal charges of the same sign requires doubly periodic or elliptic functions for its treatment. The case of cylinders of the same radius only is considered. J. J. S.

1198. Inverted Prolate Spheroids. (Miss) D. M. Wrinch. *Phil. Mag.* 14. *pp.* 1061–1070, *Dec.*, 1932.—Several potential problems, expressed in terms of electrostatic theory, but equally applicable in other branches of physics, are solved by the use of co-ordinates which are the geometrical inverses of those appropriate to prolate spheroids. J. H. A.

1199. Attractions between Resin and Mercury. K. Nakata. *Phys. Math. Soc., Japan, Proc.* 14. *pp.* 465–485, *Oct.*, 1932. *In English.*—In an earlier paper [see Abstract 3069 (1928)] the author described experiments on the charge acquired by pieces of dielectric which have been dropped on to a mercury surface. In the present paper an attempt is made to study the electrostatic attraction between the dielectric so charged and the mercury. A small spring balance is used for this purpose, and an attempt is made to trace a correlation between this attractive force and the magnitude of the charge, the latter being measured with a Faraday cylinder. It is found that above a certain limit the attractive force increases as the charge decreases. Assuming that the charge lies upon the surface of the dielectric, the separation between this surface and the surface of the mercury can be calculated from the magnitude of the charge and of the force. It appears to be of the order of 10^{-6}cm. and is of the same order as the thickness of the layer of air which might be expected to reside on the surfaces. The effect of varying the height from which the dielectric is dropped is also investigated, but it is impossible to trace any correlation between this and the charge produced. It is noted that a mercury surface contaminated by previous experiments produces larger electric charges but smaller attractive forces. The latter can be explained by the separation between the surfaces being increased by the contamination. J. E. R. C.

1200. Triboelectricity and Friction. Part VII. Quantitative Results for Metals and Other Solid Elements, with Silica. P. E. Shaw and E. W. L. Leavey. *Roy. Soc., Proc.* 138. *pp.* 502–514, *Dec.* 1, 1932.—Results are given for 17 elements. At least 10 factors are involved in the potential produced, 2 being concerned with the contact effect, 2 with the method of rubbing, 3 with the influence of surface contamination, and 3 with factors inherent in the process of rubbing, such as electrical separation. If the metals are placed in the order of the potential developed on rubbing with silica, the series is similar to that obtained for the contact effect, but there are several discrepancies. The contact effect is in general the principal factor in the triboelectric effect. H. F. G.

See also Abstracts 1179, 1190.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

1201. Hall E.M.F. and Intensity of Magnetisation. E. M. Pugh and T. W. Lippert. *Phys. Rev.* 42. *pp.* 709–713, *Dec.* 1, 1932.—Previous experiments [see Abstract 1355 (1931)] have indicated that the Hall e.m.f. depends on the intensity of magnetisation rather than upon the applied field or magnetic induction. Additional evidence is offered, the most important being that provided by a material in which H and B-H are of the same order of magnitude. AUTHORS.

1202. Resistance Variation in Ferromagnetic Crystals. R. Gans and J. v. Harlem. *Ann. d. Physik*, 15. 5. *pp.* 516–526, *Dec.*, 1932.—The behaviour of single crystals of ferromagnetic substances in a

magnetic field is discussed theoretically and is compared with experimental results. The treatment is based on two principles used by Heisenberg; (1) the conditions of symmetry of the magnetically saturated crystal are taken into account, (2) use is made of the hypothesis that the elementary regions of an unsaturated crystal are also saturated, but the directions of the magnetisation in the individual elementary regions may be different. The theoretical results are found to accord well with the experimental determinations. H. L. B.

1203. Change of Electrical Resistance with Magnetisation. W. Gerlach. *Phys. Zeits.* 33. *pp.* 953–957, *Dec.* 15, 1932.—The chief subject discussed in this summary of the results of experiment is the anomalies of resistance of ferromagnetic electronic conductors which is connected with ferromagnetism as such. The three main sections dealt with are: (1) relations between the temperature coefficients of the electric resistance and the magnetic energy; (2) change of the resistance by magnetisation in the neighbourhood of the Curie point; (3) change of the resistance by true magnetisation in high fields below the Curie point. It is pointed out that the longitudinal increase of resistance and the transverse decrease of resistance with ferromagnetic magnetisation are not two different processes but only two complementary phenomena of the same change of orientation of the elementary elements relative to the direction of current. J. J. S.

MAGNETISM AND ELECTROMAGNETISM.

1204. Magnetic Properties of the Borides of the Rare Earths. W. Klemm, W. Schüth and M. v. Stackelberg. *Zeits. f. phys. Chem.* 19. *Abt.B.* 5. *pp.* 321–327, *Dec.*, 1932.—The metallic character of borides of the formula MeB_6 is established on the basis of their electrical conductivity, whilst magnetic measurements indicate that in the borides LaB_6, CeB_6, PrB_6, NdB_6 and SmB_6 the rare earth metals are in the form of trivalent ions which embody the metallic characteristics. H. H. Ho.

1205. Ferromagnetic Crystals. R. Gans. *Phys. Zeits.* 33. *pp.* 924–928, *Dec.* 1, 1932.—A report of a general lecture on the subject of the title, including a discussion of magnetisation curves for saturated and unsaturated media, as also the magnetic behaviour of isotropic ferromagnetic materials and the mathematical significance of magnetostriction. Theoretical throughout. S. G. B.

1206. Anomalous Behaviour of Permeability at High Frequencies. W. Arkadiew. *Zeits. f. Physik*, 79. 7–8. *pp.* 558–561, *Dec.* 3, 1932.—The normal and abnormal behaviour of the permeability at high frequencies and the decrease or increase in their value with higher frequencies still has to be explained. With a view to clearing up this point the formulæ and results of a number of investigators are reviewed, whilst, finally, the recent observations of G. R. Wait [see Abstract 5273 (1932)] establish neither normal nor abnormal behaviour of the permeability at high frequency. S. G. B.

1207. Quantitative Method for Investigating the Texture of Rolled Metal. N. Akulov and N. Brüchatov. *Ann. d. Physik*, 15. 7. *pp.* 741–749, *Dec.*, 1932.—If the moment of the couple which acts on a round disc of rolled metal placed in a strong magnetic field is expressed as a function of the angle between the directions of rolling and of the

field, the texture of the rolled metal can be determined by employing the qualitative results of X-ray analysis. The method of calculation is explained with the aid of curves for hard-rolled transformer sheet and soft iron and for nickel. [See also Abstract 599 (1932).] G. E. A.

1208. Complicated Magnetic Structure of Single Ferromagnetic Crystals. N. Akulov and M. Degtiar. *Ann. d. Physik*, 15. 7. *pp.* 750–756, *Dec.*, 1932.—On the polished surface of a single iron crystal a fine magnetic powder forms distinct patterns which are visible under the microscope. The figures can be produced without applying an external field. Slip bands are visible which are also brought out by etching, and in addition two systems of lines are formed, parallel to the axes of easiest magnetisation, which do not appear in etched sections. G. E. A.

1209. Mono-Crystal Barkhausen Effects in Rotating Fields. F. J. Beck, Jr., and L. W. McKeehan. *Phys. Rev.* 42. *pp.* 714–720, *Dec.* 1, 1932.—The directions of Barkhausen effects in a single crystal disc of silicon steel, held stationary in a magnetic field rotating slowly in the plane of the disc, have been determined. Search coils at right angles picked up impulses proportional to selected rectangular components of the changes in magnetisation. Measurements on an oscillographic record were made at two values of magnetisation, 190 and 100. Values of the angle ϕ between the change in magnetisation ΔI and the corresponding variation in the applied field, $(d\mathrm{H}/dt)\Delta t$ were determined for various positions of the applied field relative to the crystallographic axes. The normal to the disc made angles of 30°, 60°, 90° with these axes. For these low values of magnetisation the effects are mainly transverse with respect to H (and therefore nearly parallel to $d\mathrm{H}/dt$) and are more nearly transverse for the greater value of magnetisation. The average value of ϕ is about 20° (ΔI lagging $d\mathrm{H}/dt$) for the lower value of I and is less than 5° for the higher value. The average magnetisation apparently lags the applied field and makes a small angle with it. The direction and frequency of effects seemed unaffected by changing the direction of H in the plane of the disc, so that no dependence upon the crystallographic directions of I, H or $d\mathrm{H}/dt$ have been established. AUTHORS.

1210. Diamagnetism of Water at Different Temperatures. A. P. Wills and G. F. Boeker. *Phys. Rev.* 42. *pp.* 687–696, *Dec.* 1, 1932.—Attention is called to the discordant results found by different observers for the diamagnetism of water at different temperatures. A new and very sensitive device called a manometric balance is described. The device was designed for the purpose of investigating the variation of the specific susceptibility of water with varying temperature. Experiments with water which had just been boiled in order to get rid of dissolved air indicated less diamagnetism at temperatures higher than 23·5° C; and experiments upon water which was boiled and left standing for several days in contact with helium gas indicated greater diamagnetism at temperatures higher than 23·5° C; the change in the specific susceptibility was less than one per cent in each case. AUTHORS.

1211. Magnetism of the Metallic Elements. E. Vogt. *Ergeb. d. Exakt. Naturwiss.* 11. *pp.* 323–351, 1932.—The experimental facts of magnetism are examined critically to find what is contributed by this group of phenomena to modern views of the structure of metals and of the metallic state. The metallic state is considered from three points, namely,

the mobility of valency electrons in the metal lattice, the lattice structure in relation to the periodic system, and the quantum theory of free ions. The paper is in four parts which deal respectively with (i) Group I of the periodic system and an approximation to an ideal metallic state ; (ii) B–sub-groups and the transition to a homopolar bond ; (iii) transition series and incomplete *d* orbits in the metal lattice ; and (iv) metals of the rare earths and free interorbital moments. [See also Abstract 770 (1933).] G. E. A.

1212. Magnetic Susceptibilities of Some Paramagnetic Substances. W. Sucksmith. *Phil. Mag.* 14. *pp.* 1115–1126, *Dec.*, 1932.—A description is given of apparatus for the measurement of magnetic susceptibilities at temperatures above or below room-temperature. The apparatus is constructed so that the observed deflections are very small, so that a linear relationship exists between the deflecting force and the resulting displacement. Results of measurements on some oxides of the rare earth group and also on salts of molybdenum and uranium are given. The measurements on the rare earth group are in strong confirmation of the theory of van Vleck, whilst the data on molybdenum and uranium salts lend support to the view that the paramagnetism of these substances is due to spin moment only. A. W.

1213. Influence of Crystalline Fields on the Susceptibilities of Salts of Paramagnetic Ions. Part II. Iron Group. Especially Ni, Cr and Co. R. Schlapp and W. G. Penney. *Phys. Rev.* 42. *pp.* 666–686, *Dec.* 1, 1932.—The paper contains a calculation of the paramagnetic susceptibility of highly hydrated crystals of Ni, Cr and Co. The metallic ion is supposed to be subject to a crystalline electric field predominantly cubic, but also with a smaller rhombic term. It is found possible to obtain the first and second order Zeeman effects, and hence the susceptibility. Further, the isotropy of Ni and Cr, as compared with the anisotropy of Co, is accounted for. The energy levels in all three elements consist of two triplets and one singlet, and if, in order to give agreement with experiment, it is assumed that in Ni the singlet lies lowest, it follows from van Vleck's work that it also lies lowest for Cr. For Co the singlet lies highest. The temperature effect on the susceptibility is also calculated. [See also Abstract 5262 (1932).] G. E. A.

1214. Ritz's Electrodynamic Theory. W. Hovgaard. *J. Math. Phys., Mass. Inst. of Technology*, 11. *pp.* 218–254, *Sept. and Dec.*, 1932.—A survey is given of the Memoirs by Ritz, published in 1908, in which he subjected Maxwell's theory as modified by Lorentz to a critical analysis and outlines a new theory of electrodynamics. A complete translation of one of Ritz's papers is given. Ritz accepted the theory of the electron, but rejected the ether : he maintained that from a strictly logical point of view Maxwell's electric and magnetic forces, which apparently play such an important part in the theory, can be entirely eliminated from it. Ritz predicted that it would be possible to reduce gravitation to electrical forces, and to determine the gravitational constant from electromagnetic measurements ; further that it would be possible to explain the slow rotation of Mercury's orbit by applying the laws of electrodynamics, when once these laws became known with sufficient accuracy. He developed formulæ to that effect. Whatever be the assumptions in detail, gravitation would ultimately depend on the dynamic constitution of the atom. J. J. S.

1215. Elastic Tension and Magnetic Properties. R. Becker. *Phys. Zeits.* 33. *pp.* 905–913, *Dec.* 1, 1932.—A theoretical discussion on the subject of the title involving a consideration of the relationship between the free energy and the direction of the spontaneous magnetisation, remanence and coercive force, etc. S. G. B.

1216. Permeability and Hysteresis by Magnetisation in the Direction of Applied Tension. F. Preisach. *Phys. Zeits.* 33. *pp.* 913–923, *Dec.* 1, 1932.—The experimental details and description of technique employed are fully stated, and the precise application to polycrystalline bodies with positive magnetostriction by the use of strong tensions is considered. A model for the velocity of propagation of Barkhausen waves is constructed on the lines of the results of Sixtus and Tonks, showing the magnetisation in the direction of tension, and the mechanism of movement of a dividing wall set up between oppositely magnetised regions. The critical field-strength is newly determined by the authors, and the results are applied to permalloy. The conclusion is made that the forces due to crystalline nature and those due to the elastic properties of the medium exert themselves, in the direction of pull, upon the magnetisation in an exactly similar manner, and the influence of the elastic and crystalline factors upon the magnetic properties of the medium is similar. S. G. B.

1217. Properties of Homogeneously Distorted Cubic Ferromagnetic Lattices. F. Bitter. *Phys. Rev.* 42. *pp.* 697–708, *Dec.* 1, 1932.—An amplification of the work of Becker and Kersten [see Abstract 3556 (1930) and 990 (1931)]. These authors use an approximation which eliminates the symmetry of the crystal, present in the original expression for the energy. The paper treats the problem with especial reference to crystallographic symmetry and the results are applied to the magnetostriction and magnetisation of iron, nickel and their alloys under tension and compression. G. E. A.

See also Abstracts 843, 884, 893, 958.

MEDICAL RADIOLOGY AND ELECTROLOGY.

1218. Ionisation of the Atmosphere and its Biological Effects. L. R. Koller. *Frank. Inst., J.* 214. *pp.* 543–568, *Nov.*, 1932.—In respect to ventilation, only temperature and moisture content of the air are usually considered. Another factor, namely, ionisation of the air, also plays a part with respect to fatigue, etc., in enclosed spaces and requires consideration. The author discusses the ionisation and potential gradient of the atmosphere generally and the methods of measurement of the degree of gaseous ionisation, particularly by the apparatus of Ebert and of Erikson, the mathematical theory of each apparatus being given in detail. The actual effects of atmospheric ionisation on living subjects have been extensively dealt with by Dessauer of Frankfort. Mountain sickness is believed to result from a high ion value of mountain air, and, likewise, the ion value appears to affect rheumatic patients. Dessauer has devised a method of increasing the ion content of the atmosphere, in which air is blown over a block of pure MgO, heated by a surrounding platinum filament, which method is more practical than others, utilising X-rays and ultra-violet rays to induce ionisation. With human subjects the presence of positive ions induces fatigue, dizziness, headaches, roaring in the ears, etc., whereas negative ions produce a feeling of exhilaration. The

blood pressure of the patient is influenced. Dessauer has obtained good therapeutic results in high blood pressure, rheumatism, gout, neuritis, etc. In 200 cases of patients with high blood pressure there was permanent improvement in 80 % of cases. The apparatus used for therapeutic purposes is described in detail. B. J. L.

1219. X-Ray Machine Outputs and Influence of Wave-Form on Quality of X-Radiation. C. E. Eddy. *Brit. J. of Radiology*, 5. *pp.* 892–902, *Dec.*, 1932.—Reference is made to the means of measuring the potential applied to an X-ray tube and the effect of potential changes on X-ray output. The paper mentions comparisons that have been made of the output of various types of X-ray generator. The estimation of the quality of an X-ray beam and the effect of filters on quality are discussed. W. E. P.

1220. Measurement of L.T. X-Ray Intensities. L. S. Taylor and C. F. Stoneburner. *Bureau of Standards, J. of Research*, 9. *pp.* 769–780, *Dec.*, 1932.—A special type of chamber has been designed to measure the ionisation produced by 3 to 12 kV X-rays in a known volume of unrestricted air, thus making it possible to express the intensity of the X-ray beam in roentgens per minute. By the use of a very small guarded field ionisation chamber (5 by 5 cm.), the air-absorption correction is reduced several fold, and hence errors in its determination are not so serious in the final result sought. It is shown that air-absorption corrections must be determined separately for each beam of radiation used, and the chamber is so designed that the necessary corrections may be determined without recourse to other special apparatus. Examples are given showing in detail the methods of making measurements with the chamber described. Compared at higher voltages (40 to 90 kV) with a large primary standard ionisation chamber, the small type here described shows a divergence of about $\pm$ 0·5 % which is believed to be the over-all error present in its use. In order to obtain this close agreement it is necessary to take special precautions in the construction and measurement of the limiting diaphragm and the collector electode. AUTHORS.

1221. Radiotherapy with Long-Continued Feeble γ-Radiation. J. Joly. *Roy. Dublin Soc., Proc.* 20. *p.* 469, *Dec.*, 1932.—It has been suggested that extra-terrestrial radiation affects organic life and that, in certain lead mines, there is comparative immunity to malignant disease, as the result of γ-radiation. To apply γ-radiation to patients the author suggests that radioactive ore, *e.g.*, uraninite, should be applied in a semi-solid state to a fabric to be worn by the patient, and details of the method of application to the fabric are given. B. J. L.

OSCILLATIONS.

1222. Generation of Ultra-Short Electromagnetic Waves by the Barkhausen-Kurz Method. G. Potapenko. *Phil. Mag.* 14. *pp.* 1126–1142, *Dec.*, 1932.—An explanation is given of the phenomena of the generation of ultra-short waves of the Gill-Morell type, using the method of Barkhausen and Kurz. The explanation covers the case of " normal " waves, the length of which corresponds to a complete period of oscillation of the electrons about the grid of the tube, and also the cases of waves of higher orders, or " dwarf " waves, the length of which corresponds to $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ . . . of the period of the electronic oscillations. The lengths of both

normal and dwarf waves can be represented by the formula $\lambda^2(E_g \pm nkI_a) = \text{const.}/n^2$, n being unity for the normal waves and having the values 2, 3, 4 . . . for the dwarf waves of corresponding orders. This formula is more general than the formula $\lambda^2 E_g = \text{const.}/n^2$, which was given previously by the author and which includes Barkhausen's formula as a particular case. A. W.

1223. Rapid Brightness Fluctuations in Lamp Filament. G. Wataghin. *Accad. Sci. Torino, Atti*, 67. 11–13. *pp.* 309–315, 1931–1932.—Describes a method for producing very rapid fluctuations of brightness in a lamp filament. Instead of altering the current passing through the filament, it is alternately heated and cooled by the reception or emission of electrons. This process is controlled by the space-charge surrounding the filament so that, in the final result, rapid alternations (*e.g.*, of the order of 10,000 per sec.) impressed on the space-charge produce a periodic charge of the same frequency in the brightness of the filament. The amount of power required to produce given fluctuations is quite small. A second method, *viz.*, the bombardment of the filament by an intermittent stream of electrons, is also proposed. The results of experimental work on these effects are given in another paper [see two following Abstracts].

J. W. T. W.

1224. Rapid Brightness Fluctuations in Lamp Filament. R. Deaglio. *Accad. Sci. Torino, Atti*, 67. 11–13. *pp.* 353–362, 1931–1932.—Describes the results of experimental work following the theory of G. Wataghin [see preceding Abstract]. The filament used was that of a Philips D2 triode, taking a current of 0·55 ampere. At a frequency of 9000 ~, the smallest current which would produce a perceptible fluctuation in the brightness of the filament was 0·090 ampere, and the least energy required was approximately 1 watt. By making use of the method proposed by Wataghin (modification of the space-charge surrounding the filament) a perceptible fluctuation could be produced at this frequency by the expenditure of 0·2 watt. At higher frequencies (up to 15,000 ~) fluctuations could still be obtained with an energy expenditure of about 0·2 watt by using the space-charge method, while an expenditure of 1·5 watts was required by the ordinary method. The other method proposed by Wataghin, *viz.*, intermittent bombardment of the filament by electrons, was also tried experimentally and it was found possible to produce brightness fluctuations with a frequency as high as 17,000 ~.

J. W. T. W.

1225. Light from a Filament Heated by Electronic Bombardment. G. Wataghin. *Accad. Sci. Torino, Atti*, 67. 14–15. *pp.* 524–526, 1931–1932.—When an antikathode is bombarded by electrons having a velocity of some tens of kilovolts, the radiation it emits is different from that given by a black body at the same temperature. The author finds that when the velocity is much lower (*e.g.*, 350 volts) the light given by the bombarded metal is identical in spectral distribution with that given when the metal is heated to the same temperature by the passage of a current through it. [See two preceding Abstracts]. J. W. T. W.

1226. Magnetic Rotation of the Plane of Polarisation of Electromagnetic Waves in Ionised Gases. P. Keck and J. Zenneck. *Hochfrequenztechn. u. Elektroakustik*, 40. *pp.* 153–158, *Nov.*, 1932.—Research is described in which the magnetic rotation of the plane of polarisation of very short electromagnetic waves in ionised gases was

measured. In the transmitter a dipole was used, the elements of which were 7 mm. long and 1·5 mm. in diameter. This was fed by spark-gaps from two straight conductors supplied with 8000 volts at 500 cycles. The receiver consisted essentially of a small aerial of about half a wavelength, made of Wollaston wire, a small portion at the centre being reduced to the Pt core only, which was about 0·2 μ thick. This arrangement was mounted in a vacuum chamber and leads from the ends of the centre portion passed through the base of the chamber to a Wheatstone bridge. A system of paraffin lenses was used for rendering the radiation parallel and for concentrating it on the receiver. The gases used were Ne, A and N at pressures ranging from 4 to 120 $\times$ 10^{-3} mm. Hg. The rotations observed with the magnetic fields used, which were of the order of 40 to 75 gauss, varied with the conditions of test between 1·5° and 45°. The results were found to be in very good agreement with theory. A. W.

1227. Faraday Effect in Ionised Gases for Waves 4 cm. in Length. P. Keck. *Ann. d. Physik*, 15. 8. *pp.* 903–925, *Dec.*, 1932.—Describes with greater detail the research dealt with in an earlier paper [see preceding Abstract]. A. W.

See also Abstract 873.

PHOTOELECTRICITY.

1228. Method of Measuring Photoelectric Currents in Semi-Conductors. B. Schönwald. *Ann. d. Physik*, 15. 4. *pp.* 395–421, *Nov.*, 1932.—By separating and amplifying the intermittent photoelectric currents which occur when an intermittent source of light is used from the very much greater dark currents that occur in the case of semi-conductors, the authors succeed in measuring the intensities of the currents. A suitable amplifying device is described in detail. The internal photoelectric effect in Cu_2O is investigated, and reasons are given for irregularities of behaviour. It was also found that besides the well-known maximum at the absorption edge 0·63 μ there are two other maxima at 0·8 and 0·2 μ for the photoelectric output. Results are given of photoelectric effects produced by secondary currents in commercial selenium, the above method of amplification being used. H. L. B.

1229. Photoelectric Emission from Different Metals. H. C. Rentschler, D. E. Henry and K. O. Smith. *Rev. Sci. Instruments*, 3. *pp.* 794–802, *Dec.*, 1932.—The metal is put into the form of a wire and purified by a special process based on sputtering. The characteristic curves for different cells of the same metal are exceedingly uniform. The method appears to give metal surfaces capable of giving the true photoelectric effect of the metal under test. The value of the photoelectric work function for tungsten and tantalum agree with the values of the thermionic work functions for these same metals. The photoelectric work functions for solid thorium, uranium, zirconium and calcium are higher than the thermionic work functions reported for monomolecular layers of these metals on tungsten, apparently supporting the commonly accepted theory that the thermionic emission of such a thin layer is higher than that for the solid metal. The photoelectric data for barium and for materials present in oxide-coated kathodes used in radio valves indicate that the activated oxide-coated kathodes contain something which has a lower work function than that of pure barium alone. A simple method is described for making photoelectric cells sensitive to radiations of wave-

length 2500 Å or shorter without the use of quartz, which is expensive and difficult to work. E. E. F. d'A.

1230. Gasfilled Photoelectric Cells. G. A. Boutry. *J. de Physique et le Radium*, 3. *pp.* 520–536, *Nov.*, 1932.—The properties of gas-filled potassium cells (having a surface sensitised by a discharge in hydrogen) are studied in detail to ascertain under what conditions the cell can be used for accurately measuring luminous flux. The source of light used is a tungsten ribbon lamp. The author finds that when the cell is operating near the discharge potential the increased sensitivity is obtained at the expense of accuracy. Moreover, there is a certain optimum value of the external resistance of the circuit for which the sensitivity passes through a maximum. It is found, *e.g.*, that for a flux of the order of some tenths of a lumen it is best to use a resistance of about 500,000 ohms for a certain type of cell. L. H. B.

1231. Inertia in Gas-Filled Photoelectric Cells. F. Ollendorff. *Zeits. f. techn. Physik*, 13. 12. *pp.* 606–611, 1932.—Townsend's mechanism of discharge is adopted as the most serviceable hypothesis for the positive and negative convection current, and it is assumed that the electrone only ionise in space, whereas the positive carriers only produce new carriers by surface ionisation at the kathode. A mathematical series is given for the formation of the electron current due to a sudden illumination of the kathode. In this case the current is built up out of a series of elementary " avalanches." E. E. F. d'A.

1232. Action of a Magnetic Field on a Gas-Filled Photoelectric Cell. P. Fourmarier. *Comptes Rendus*, 195. *pp.* 1387–1389, *Dec.* 27, 1932.—The application of a magnetic field to a photoelectric cell at right angles to the electron stream has the effect of reducing the current. The reduction of the electron current only becomes apparent when the driving voltage exceeds 50 (in helium) or 100 (neon, argon). It then becomes very rapid, and the current may even be brought to zero. The effect is least where the electrons have the greatest velocity. E. E. F. d'A.

1233. Rating of Photoelectric Tubes. L. R. Koller. *Rev. Sci. Instruments*, 3. *pp.* 760–761, *Dec.*, 1932.—The rating of tubes in terms of current per lumen is criticised on account of the infra-red sensitivity, and it is suggested that it be changed to amperes per lumen when illuminated by a light source at a given temperature. F. S.

1234. Photoelectric Cells. N. R. Campbell. *Journ. Sci. Instruments*, 9. *pp.* 369–373, *Dec.*, 1932.—A discussion of some modern cells. It is proposed to call blocking-layer cells " rectifier cells," to distinguish them from the Hallwachs (emission) cells and from selenium cells (photo-conductors). A rectifier cell is essentially similar in construction to a Westinghouse dry rectifier and consists of a layer of a semi-conductor S, *e.g.*, cuprous oxide or selenium between two metallic electrodes M, M′. The rectifying properties of the combination depend on the fact that under an electric field electrons pass more readily from M to S than from S to M. Its photoelectric properties depend on the fact that under the action of light, and in the absence of any external e.m.f., electrons pass from S to M rather than from M to S. These electrons tend to establish a p.d. between S and M ; if the external circuit is broken, they will return as a conduction current from M to S within the rectifier ; if the external circuit is made, the return current will be divided between the internal and external circuits

in the ratio of their conductivities. In order that light may reach the rectifying junction, either M or M′ must be transparent. In the earlier cuprous oxide cells (*Hinterwand*), M was a copper plate by the oxidation of which S was formed, and M′ a grid superimposed on it; the light passed through S to reach the junction. In the later cuprous oxide cells and in the selenium cells (*Vorderwand*), M is a partially transparent layer of metal (usually gold) deposited on S by evaporation or kathodic sputtering; M′ is a thick plate providing mechanical strength. For light from a source at 2700° K. the emission is about 100μ A/lumen for cuprous oxide cells; as much as 300μA/lumen has been claimed for selenium cells. This high emission, combined with mechanical robustness and cheapness, is the great advantage of the rectifier cell. But full use will not be made of it unless r, the resistance of the external circuit containing the indicating instrument, is so small compared with R, the resistance of the internal circuit, that practically all the photoelectric current flows in the former. If this condition is not fulfilled the measured current will be less than that corresponding to the emission. Moreover, it will not be truly proportional to the radiation; for R decreases as the radiation increases; and the current will increase less rapidly and will tend to a finite limit. Nevertheless they have a field of use in which they are unrivalled, namely, for rough measurements of not less than 1/100 lumen. In this field lie portable illumination photometers, commercial lamp photometers when errors of 1 or 2 % are permissible, and relays for galvanometers. For the first two of these applications the frequency-emission curve, giving the variation of sensitivity through the spectrum, is important. The curve for the "*Vorderwand*" cuprous oxide cell approximates to the eye visibility curve more nearly than that of any unscreened emission cell. The selenium cell, which is rather more sensitive to white light, has its maximum of sensitivity towards the red, and is therefore somewhat less suitable, although it is actually used. E. E. F. d'A.

1235. Internal Photoelectric Effect in Crystals. A. H. Wilson. *Nature*, 130. *pp.* 913–915, *Dec.* 17, 1932.—An outline is given of the theoretical principles which govern the photoconductivity. It is known that the energy spectrum of an electron moving in a perfect lattice splits up into bands of allowed and disallowed energies, and if there are just sufficient electrons present to fill up one of the allowed bands there can be no conductivity at absolute zero temperature. If an electron is placed by any process in an unoccupied band it becomes a "free electron." If there are not quite enough electrons present to occupy a band fully then the resulting "holes" are free to move through the crystal, and behave like free electrons with positive charge. In an insulator in the pure state there are just sufficient electrons present to fill up one of the bands, and any conductivity is due to the presence of impurities, or has been produced artificially by electron bombardment or by the action of light. As a typical allochromatic insulator sodium chloride is considered, and for simplicity only a one-dimensional lattice of n sodium atoms and n chlorine atoms arranged alternately. The explanation given in the paper is similar in many respects to the explanations put forward during the past decade by Gudden and Pohl. J. J. S.

1236. New Photoelectric Phenomenon. Q. Majorana. *Comptes Rendus*, 195. *pp.* 1258–1260, *Dec.* 19, 1932. *Phys. Zeits.* 33. *pp.* 947–952, *Dec.* 1, 1932.—Confirms the new photoelectric phenomenon already

described [see Abstract 5223 (1932)], and finds that it is best to experiment with sheets of platinised glass on which an intense light falls periodically. The resistance seems to increase under illumination. In the case of a bright, polished sheet of glass the phase difference between the light pulsations and the change of resistance was zero at frequencies of 600 or 700 ~. At a frequency of 300 ~ it rose to 45°. It remained at the same value in the case of a smoked sheet, but fell to zero again on immersing it in water. There is, therefore, an instantaneous light effect in addition to the heat effect. E. E. F. d'A.

1237. Smoke-Density Meter. R. D. Bean. *Journ. Sci. Instruments*, 9. *pp.* 391–392, *Dec.*, 1932.—Describes a smoke-density meter for use in chimney-stacks and based on the principle of passing light from an electric bulb through the smoke in a stack to a photoelectric cell, with electric registration. The source of light and the photoelectric cell are kept clear of soot. A. D.

See also Abstracts 843, 926, 990, 991, 997, 1011, 1053, 1090, 1241.

PIEZOELECTRICITY.

1238. Piezoelectric and Dielectric Characteristics of Rochelle Salt. E. Schwartz. *E.N.T.* 9. *pp.* 481–495, *Dec.*, 1932.—The piezoelectric characteristics of Rochelle salt are influenced by the dielectric anomalies. Pressure and piezoelectric charge are not proportional. The dielectric constant depends on field strength and time of charge. It increases with the field-strength to a maximum and then bends down in a descending branch in which the dielectric constant is independent of the time of charge. The temperature connection of the dielectric constant (d.c.) is established, and the course of the d.c. with the temperature and the times of charge is given. The piezoelectrically measured d.c. traverses a temperature course corresponding with small times of charge. The d.c. perpendicular to the *a* axis is influenced by mechanical pressure and is smaller with increasing pressure. Perpendicular to the *c* axis it has a normal value. A relation is given indicating the dependence of the dielectric density of charge on the time of charge of the Rochelle salt. An account is given of a piezoelectric microphone. J. J. S.

1239. Longitudinal and Flexural Vibrations of Tourmaline Plates. V. Petržilka. *Ann. d. Physik*, 15. 8. *pp.* 881–902, *Dec.*, 1932.—Forms of vibration of tourmaline plates cut perpendicular to the optic axis are considered. According to Love's theory, three kinds of vibration in the plane of such a plate are possible. The observed and calculated frequencies of two of these are found to be in good agreement. A third kind of vibration is observed, but it is not possible to identify this positively with Love's third vibration. Torsional vibrations of the plates are also investigated and the frequencies agree with those calculated on the basis of Kirchhoff's theory. G. G. S.

THERMIONICS.

1240. P.D. Between Incandescent Tungsten Electrodes at Different Temperatures. F. Kuhn. *Ann. d. Physik*, 15. 7. *pp.* 825–841, *Dec.*, 1932.—Discusses Richardson's formula for the " concentration cell " formed by two tungsten strips maintained at different temperatures of incandescence. Temperatures are measured optically by means of a

Holborn-Kurlbaum pyrometer. The p.d. of the concentration cell, at a first approximation, is $E = RT \log_e\left(\frac{c}{c-dc}\right)$. It must be independent of the volume charge produced between the electrodes, and its values are somewhat higher than those obtained from Richardson's formula.
E. E. F. d'A.

1241. Emission of Grids in Triodes. M. Pinna. *N. Cimento*, 9. *pp.* 302–311, *Nov.*, 1932.—Furnishes a new explanation of the secondary emission of the grid of a triode. He attributes it to a photoelectric emission of the grid due to the soft X-rays generated by the electrons of the kathode impinging upon the anode. E. E. F. d'A.

1242. Slanting Emission of Electrons from Incandescent Metal Surfaces. H. Seemann. *Zeits. f. Physik*, 79. 11–12. *pp.* 742–752, *Dec.* 30, 1932.—In consequence of the crystalline roughness of the surface of an incandescent tungsten wire, the electrons are emitted in directions making considerable angles with the normal, the emission taking place perpendicular to the microscopic crystal facets. Photographs taken with a pin-hole camera indicate that the electrons are emitted from a series of craters which approximate to point sources and which are distributed along the wire in an irregular manner. The photographs obtained with the pin-hole camera are somewhat like Röntgen ray photographs showing crystal structure. A. W.

1243. Circuits with a Capacity in Parallel with a Saturated Diode. C. Dei. *Accad. Lincei, Atti*, 16. *pp.* 334–342, *Oct.*, 1932.—The author referring to his previous papers [see Abstracts 908 and 909 (1929)] gives experimental verification of the chief theoretical results in the case of a circuit having in series a self-induction, a resistance, a diode, and an e.m.f., together with a capacity in parallel with the diode. Interpretations are also given with recourse to geometrical representation of the sinusoidal magnitudes, and to symbolical calculation. J. J. S.

THERMOELECTRICITY.

1244. Peltier Effect in Accurate Temperature Measurements. M. Lang. *Zeits. f. techn. Physik*, 13. 10. *pp.* 494–496. 1932.—The Peltier effect is included in the errors which have to be considered in thermoelectric measurements. An expression is given for the determination by calculation of the error in the temperature caused by it, and it is shown in what cases this error is to be considered. Calculation of the Peltier error shows that in the thermoelectric determination of high temperatures with the usual methods of measurement this error with certainty lies within the attainable general accuracy of the measurement. In the accurate determination of low temperatures and the use of special methods of measurement connected therewith the Peltier error may appear. J. J. S.